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CIS

ENERGY RESILIENCY

HEARING
BEFORE THE
SUBCOMMITTEE ON
ENERGY, NUCLEAR PROLIFERATION, AND
GOVERNMENT PROCESSES
OF THE
COMMITTEE ON
GOVERNMENTAL AFFAIRS
UNITED STATES SENATE
NINETY-SEVENTH CONGRESS
SECOND SESSION

MAY 21, 1982

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ENERGY RESILIENCY

FRIDAY, MAY 21, 1982

U.S. Senate,
Subcommittee on Energy, Nuclear
Proliferation, and Government Processes,
Committee on Governmental Affairs,
Washington, D.C.

The subcommittee met at 10:35 a.m., in room 3302, Dirksen Senate Office Building, Hon. Charles H. Percy (chairman of the subcommittee) presiding:

Present: Senators Percy and Cohen.

Staff present: William Strauss, Howard S. Marks, and Scott Ulm.

OPENING STATEMENT OF SENATOR PERCY

Senator Percy. At this morning's hearing of the Senate Subcommittee on Energy, Nuclear Proliferation, and Government Processes, we are going to address a vital but very much overlooked element of America's energy situation—you might call it "energy resiliency."

Simply put, the question is just how susceptible our energy infrastructure may be to terrorism or sabotage—and just what we can do to reduce that vulnerability.

Having spent the last 45 minutes or so with Ambassador Henderson of the United Kingdom, we recognize how dangerous any given situation can be in the world in which we live today.

A brewing war in the Falklands is a reminder that the 1980's could be a very dangerous decade. We are starting to see indications that the oil glut is tapering off. I am firmly convinced that we shall someday find ourselves face to face with energy shortages at least as severe as those we faced in the 1970's.

The next time those shortages may involve more than just a cutoff of oil imports, gas lines, or rising prices. They may come at a time of greatly heightened global tensions, international terrorism, or even military confrontation.

I hope I am wrong about this, but I am fearful that given the worldwide economic conditions we may see expanding activities of terrorist groups which may have access to all the personnel and money they need, high technology weapons, and sensitive intelligence. We have to brace ourselves for this possibility.

No one can doubt the importance of energy to the security of the United States. For our economy to function and for our defense apparatus to remain fully capable, our energy production, storage, and transportation facilities must be able to function well no matter what the circumstances.

If an international terrorist group or anyone else ever wanted to do the United States real harm, this energy infrastructure is one place they might attack.

I think it is a forgotten Achilles Heel in our entire defense posture.

I think all we need to do also is recognize what has happened in recent years just in terrorism of individuals. We can think back on many assassinations and the many kidnapings that have occurred with American diplomatic personnel abroad.

In contrast to the previous years, it was a phenomenon that was simply not nearly as common as it is today. I am pleased with the vigor with which the State Department has moved on this. We have really backed, supported, and insisted upon adequate protection for our diplomats abroad. But the protection now used there is comparable to the protection which we have never needed in the Capitol and in the Senate Office Buildings which we must now use. It is the same kind of protection that we have at airports.

We have just had to take extraordinary precautions because of this phenomenon of terrorism.

To think that our vital resources that are the heart of our defense, that are the superstructure, the foundation of our whole economy would not be subject to attack would be naive on our part.

For that reason, some of our witnesses today will describe our energy system that has evolved over the years with only limited regard to its physical vulnerability. Anyone who takes a quick glance at the maps around this room can see that there are some choke points in our energy transportation systems, for example.

Certainly, we cannot change transportation and storage systems already in place, but we need to do whatever we can to make them more resilent, more secure, and ultimately less vulnerable.

The most obvious choke point, of course, is the Straits of Hormuz through which most of the oil for the free world flows. Choke that off, cut it off, and that could decimate the economy of Japan; seriously cripple Europe and certainly do great damage to the United States of America.

We have spent $11 billion in rapid deployment forces in protecting and guarding that one possible choke point there, or the activities of terrorism in the Middle East, if it occurs, but there are many, many other areas throughout the world that would be vulnerable spots.

This may simply mean maintaining the ability to contain damage and repair it quickly, or it may require having backup or redundant systems to insure that energy will continue to be delivered regardless of any possible damage.

In isolated cases, it may mean more guards, more fences, more security perimeters.

Smoke and fire we could live with, but not month-long blackouts, or hard to fix pipeline disruptions or any lasting damage to the strategic petroleum reserve. One way or the other, we simply must reassure ourselves and alert terrorists or other adversaries that attack on our energy facilities would cause us no lasting harm, and we have to take out the insurance policies that will protect that.

We cannot afford to live without those insurance policies today.

A year-and-a-half ago, I asked my very able staff to begin looking into this. Top officials in the Energy Department not only had no answers to our questions at that time, but they did not even understand why we were asking them. They seemed quite redundant to some of them at the time.

Now we have an administration that is really taking emergency preparedness seriously. At my urging, it has focused on these questions, and they have initiated programs on their own that have been completely consistent with the concerns that we all now share. They have already taken action to improve the security of the Strategic Petroleum Reserve among other things.

I would like to see these efforts expanded. I would particularly like to see the Federal Emergency Management Agency and the Defense Department get more involved. Following this hearing, I shall introduce legislation calling for an interagency coordinating council, headed by FEMA, to review these security issues and report back to the Congress about any further public or private sector action needed to make our energy facilities less vulnerable.

I would also like to see security considerations given greater weight in decisions made about the future evolution of the Strategic Petroleum Reserve and any civilian power systems of direct significance to our military or communications capabilities.

Finally, I think we need to begin asking these questions as we do research, promote technologies, or set policies which may affect our energy system in the 1990's or beyond.

I generally support the administration's move toward a free, unregulated energy marketplace, but there are important factors—like resiliency and national security—a free market will not adequately consider.

Decentralized, widely dispersed energy systems, like solar energy, alcohol fuels, and especially energy conservation, will almost always be more resilient and more secure than centralized ones.

Also, as any businessman can tell us, diversification always brings an extra margin of safety.

Yesterday, I introduced a bill, S. 2554, the Commodities Surplus Disposal Act of 1982, which will contribute to a more diversified and resilient energy supply by promoting the conversion of surplus corn to alcohol fuels. I will have more to say about this bill later in the hearing.

These alternative energy technologies have already suffered sharp budget cuts and reduced priorities in this administration, but I am beginning to see some signs that, thanks to some prodding from many of us at this end of town, things may be turning around.

We do have some receptive and sympathetic ears that have been listening to us and that we have been consulting with. I hope our hearing today will provide extra impetus in continuing a Federal role in developing and promoting these technologies.

Before us this morning we have as our first witness today Hon. William A. Vaughan, Assistant Secretary, Environmental Protection, Safety and Emergency Preparedness, from the Department of Energy. In that capacity, and with that responsibility, he is responsible for DOE's emergency and contingency planning as well as the Naval

Petroleum Reserve, the Oil Shale Reserve and the Strategic Petroleum Reserve.

Before joining the administration, he was director of the energy management staff of the General Motors Corp. in Detroit.

Mr. Vaughan is both a registered professional engineer and an attorney. In 1980, he was named Man of the Year by Modern Energy Magazine.

Mr. Vaughan, I am delighted you will be testifying today. I look forward to hearing about the work being done by your staff to examine the current weaknesses in our energy supply and storage system.

As you may know, I have at times been critical of some of your DOE colleagues in conversation and some other areas, but it is a refreshing change and a pleasant change for me to simply state I have been filled with praise for the work you and the DOE policy office have been doing together in the energy preparedness field. You have not just talked about filling the Strategic Petroleum Reserve, you have gone out and filled it. You are filling it. You have tripled its size. You have done so at favorable prices. It is just money in the bank. It is one of the best investments this country has ever made. You have done so in a period of just 14 short months.

In my view, this stands as one of the biggest, yet unheralded, accomplishments to date of the Reagan administration.

Senator Cohen, we are delighted to have you here. If you have any opening statement——

Senator **Cohen**. No, Mr. Chairman.

Senator **Percy**. Fine.

Secretary Vaughan, if you would like to introduce your colleague, and then following that, you can give your statement. The full text of your statement, by the way, will be incorporated in the record.

TESTIMONY OF WILLIAM A. VAUGHAN, ASSISTANT SECRETARY, ENVIRONMENTAL PROTECTION, SAFETY AND EMERGENCY PREPAREDNESS, DEPARTMENT OF ENERGY, ACCOMPANIED BY RICHARD FURIGA, DEPUTY ASSISTANT SECRETARY FOR STRATEGIC PETROLEUM RESERVE

Mr. **Vaughan**. Fine, Senator.

I have with me here at the table, Mr. Richard Furiga, Deputy Assistant Secretary in charge of the Strategic Petroleum Reserve. I also have here with me this morning Mr. Ronald Winkler, the Deputy Assistant Secretary for Energy Emergencies, and Capt. Gordon Gillmore, the Director of the Naval Petroleum and Oil Shale Reserve, in the event that you are desirous of going into intimate details on some of these matters.

As you well know, I have filed a more lengthy statement for the record. At this point, I will try to summarize my remarks and hit the key points.

It is certainly a pleasure to have the opportunity to be here this morning and to discuss with this committee the resiliency of our Nation's energy supply and distribution systems to disruptions which could be caused by major accidents, natural disasters, sabotage, or terrorism.

We have had an opportunity to meet with members of the subcommittee staff to discuss this subject on several occasions and share your concern, the committee's concern, on the importance of this topic.

As I will discuss, we, at DOE, believe that we have underway several projects which address these issues in a way which will help assure the viability of our national energy system.

Based on the studies and the reports which have been done in the past and on recent work done by the Department in conjunction with other Federal agencies, it is our preliminary view that the Nation's major energy systems have a significant degree of resiliency.

But the fact cannot be ignored that domestic energy systems such as oil or gas wells, pipelines, nuclear powerplants, and conventional electric generators could become targets of unexpected disruptions, including sabotage.

With this in mind and because energy is so critical to the national welfare and security, the Department is presently involved in a project assessing the vulnerability to terrorism, sabotage, and accidents in the electric utility network, natural gas and petroleum pipelines, including, specifically, the Strategic Petroleum Reserve and the Naval Petroleum Reserves distributions systems, and other parts of the broad national energy system.

Rather than attempting to systematically examine every facility and every part of the energy system across America that might be vulnerable to various energy disruptions, the DOE is undertaking a selective case study vulnerability assessment program, examining a number of carefully selected case studies that we have chosen because they are most illustrative of the ranges of possible vulnerability to disruption problems.

Senator PERCY. Mr. Secretary, if I can interrupt just a second, we have a rollcall vote on. I have read your statement. I am going to go down and vote so we don't have to recess, and then Senator Cohen will pick up when I come back.

Mr. VAUGHAN. I fully understand, sir.

Senator PERCY. Thank you.

Mr. VAUGHAN. This approach will avoid placing an unnecessary information -gathering burden on private industries and other organizations and duplicating many of the responsibilities of other Federal and State agencies, as well as of the private sector.

Briefly stated, our objectives are to work in conjunction with the Congress, other Federal and State agencies, and appropriate elements of the private sector to accomplish the following: One, to identify and assess key energy vulnerabilities; two, to develop proposals as needed for reducing these vulnerabilities and report on the state-of-art as to possible corrective measures; three, encourage the appropriate organizations to take actions that will reduce these risks and vulnerabilities; four, prepare to respond appropriately if events occur that are beyond the resiliency of the Nation's energy system.

The program is being managed by the Department's Office of Energy Emergencies with the assistance of other offices within the Department. Also, the DOE staff is coordinating its effort with the Department of Defense, the Federal Emergency Management Agency, relevant intelligence agencies, and with appropriate energy industries and other key private sector organizations.

A cooperative assessment effort is essential in order to develop a balanced, sound understanding of these problems and to reach a consensus on what measures, if any, should be undertaken.

A primary concern in such an undertaking is the protection of sensitive information. We are taking every precaution to avoid producing a "blueprint" on how to disrupt the Nation's energy supplies as we try to study the problem.

The first priority of the Department's program is to assess the vulnerability of the Nation's military capability to major acts of sabotage against domestic energy systems.

The program's focus is on defense energy needs first, because it is illustrative. It is expected that what we learn in examining resiliency of energy systems serving defense facilities will be applicable to our review of the energy vulnerability of key facilities in the private sector.

Although the primary concern of the program at this point is energy disruptions caused by deliberate hostile acts, we also plan to examine the resiliency of key facilities to disruptions caused by natural disasters or accidents that are sufficiently severe to cause or have a serious national impact.

The electric power portion of the DOE study program is well underway. The Department staff has coordinated closely with the Defense Department to identify military installations and defense industrial producers that cannot operate without commercial electric power and whose disruption during a period of military activity could significantly impact the Nation's combat readiness.

A few case studies have been conducted of critical military bases selected by the Air Force. In addition, the DOE staff is reviewing previous incidents of sabotage against domestic power systems determining the kinds of sabotage that could cause disruptions and assessing the ability of the industry, that is, the electric power industry, to secure critical facilities.

Work on the electric power study has not progressed far enough to permit the drafting of definitive conclusions at this point, but I can offer three general observations which I believe are important: First, one cannot conclude that a threat to national security necessarily exists simply because the power system to a defense installation could be interrupted. It is quite possible that a moderately long power outage at a particular installation might cause no discernible impairment of actual combat capability.

With help from the Defense Department, DOE is trying to estimate the tolerable duration of outages for each of the case studies. These estimates, combined with the examination of the physical vulnerability and restoration capability of the utility, will yield a basis for estimating the vulnerability of actual military capability to power disruptions.

Second, it is important to consider the structure of our defense establishment and the manner in which its energy needs are supplied. The Defense Department has a longstanding policy of avoiding excessive dependence on any single defense base or any single industrial supplier.

The relatively few facilities that are unique and time-urgent, such as command centers or strategic forces, usually have onsite primary or backup power supplies. Even at facilities that do depend critically on commercially supplied power, there is some tolerance for interruptions of moderate duration. This means that some time is available for the utility to restore service before a measurable impairment of military capability could occur.

Third, it is important to recognize the ability of the utilities to restore power. As I indicated at the outset, modern electric power systems are generally, in our judgment, resilient. There are a large number of powerplants, so no single one is critical. There are many alternate transmission and distribution routes. The electric utilities have large repair forces, and they maintain inventories of almost all replacement parts except for certain very large, unique items.

The electric utilities also have standing arrangements with neighboring utilities to share production and repair resources during emergencies.

Finally, during emergencies, they can resort to load-shedding or can even break their system into separate operating regions called "islands," so that priority loads can be served even when the system is badly crippled.

The DOE natural gas system vulnerability assessment project is just beginning. It will first be necessary to determine if there are critical defense facilities that cannot tolerate an interruption of natural gas supply. If not, the focus will be on the vulnerability of the general economy to sabotage, or terrorism directed against the natural gas supply system.

The DOE petroleum vulnerability study will focus on the Alaska pipeline and on the system for distributing oil from the Strategic Petroleum Reserve. It is also expected that an examination of other selected pipelines, refineries, and port facilities will be performed. DOE may also look at the potential contribution of alternative liquid fuels, such as methanol or ethanol.

In addition to these projects, DOE has investigated a number of other areas of energy resiliency and is continuing some of these efforts at the present time.

For example, we have looked at the vulnerability of nuclear powerplants and related facilities, security and vulnerability onsite at the strategic petroleum reserve and the naval petroleum shale oil reserve and selected issues relating to transportation modes such as waterways and railroad systems.

I do not want to give the impression that we are prejudging the resiliency of the Nation's energy system against acts of sabotage or other disruptions.

In a serious case, the potential exists that the general population might suffer some level of hardship even if defense facilities are kept operating.

We need to know more about the range of possibilities which might occur and potential levels of hardship which could be experienced.

Let me reassure you on one more point: We recognize that the owners of energy facilities in the private sector have a strong interest in providing reliable, resilient, and secure energy supply systems. This interest in avoiding disasters on the part of the private sector is a vital aspect of any overall security system.

In conducting our studies, we, in DOE, intend to respect private sector prerogatives and to avoid any hint of harassment or suggestion that the Government alone is concerned about security.

You can be assured that the Department of Energy and the administration take the question of resiliency of the domestic energy system very seriously, and we are vigorously examining the resiliency issue within the parameters which I have described.

At this point, Senator, I am open to your questions.

Senator COHEN. Tell me, Mr. Vaughan, what do you know the private sector is doing about taking measures on a coordinated basis to protect our energy supplies against terrorist attacks?

Mr. VAUGHAN. The private sector, if I may turn to the electric power industry as an example, has looked at this question for some time and is looking cooperatively with us now on this subject.

One of their concerns—and I fully support it—is that we not create a target list or blueprint for knocking out or seriously damaging the Nation's electric power system.

Senator COHEN. You think that terrorists, as sophisticated as they are today, are unaware of the key points we have, for example, a nuclear powerplant in the State of Maine? That is not a national secret.

Do you know whether Maine Yankee has done anything in the way of providing for protection against a terrorist attack against that particular unit?

Mr. VAUGHAN. Senator, there is a limit as to how secure you can keep information. Obviously, installations such as that particular powerplant are known. There is also a practical limit, I think, sir, to how much the facility can do in the way of protection.

Senator COHEN. That is precisely the point.

Is it fair to say at the very core of our success lies the seeds of our own potential destruction, namely, because we do have a success as a society because of our freedoms; our social and judicial system; other economic freedoms that we enjoy; at the very core of those freedoms lies a very dangerous potential for our destruction?

That would apply also, I assume, to our success as a society industrially, economically, that we depend upon high technology which, in turn, has depended upon energy sources which are, perhaps, the most vulnerable that we have, that is, oil and nuclear.

Now, it seems to me that we are making a fundamental mistake to back away from this situation and simply say, "Well, we don't want to publicize the fact that we have all of these choke points or dangerous interruptions of supply because we don't want to tip off the enemy or terrorists any more than we have to." It seems to me we have to do more than that.

Mr. VAUGHAN. I certainly don't want to indicate that by referring to not making a roadmap or blueprint that that is anywhere near the extent of what is going on.

I do caution, and I am quite concerned along with the industry, that we not create such a document that is publicly available. While I will agree with you that trained, seasoned saboteurs can do a tremendous amount of damage and can, undoubtedly, ferret out a lot of information on their own, we do have other types of sabotages that we ought to be concerned about that may be of a much greater number. That is the type associated with civil disorder and that sort of thing that really amounts to amateurs.

Information of this type in the hands of amateurs could create problems that do not now exist, in my judgment.

Senator COHEN. Let me suggest to you that there are no longer amateurs out there. There are a lot of very sophisticated terrorists out there. We have yet to see that terrorism fully imported into the United States. It seems to me what we ought to be doing is trying to develop the kind of energy resources that minimize the potential for disruption.

I can recall, for example, we talked about nuclear power. In my own State where I was testifying against shutting down Maine Yankee—I stand by that—but I said one of the reasons they are trying to shut it down was because of the danger of earthquakes in Maine; that it might disrupt the backup pipes that we had for it.

I remember testifying over at the House of Representatives, I said, "That is ridiculous. We don't have earthquakes in Maine."

Three weeks after I made that statement, there was an earthquake in Maine and then a second one.

Some of us are called upon to eat our words from time to time. That was one in which I did, certainly. All I am suggesting is that we ought to recognize that our success is dependent upon, it lays upon a certain vulnerability. That vulnerability is our vulnerability to high technology, which we have based upon nuclear and oil. Those are two very vulnerable sources, and we ought to be moving away from that direction to something else that is less vulnerable to the kind of terrorist attacks which is the wave of the future.

Mr. Chairman, I have got to go vote.

Senator PERCY. I would just like to, first, repeat what I said before and to express my appreciation for the attention that you have paid, Mr. Secretary, to the issue of energy security. You can imagine how frustrating it has been in previous years to be talking to a blank wall, where no one really exercised or got excited about these concerns. Now we have a real interest this administration.

In fact, your job as Assistant Secretary for Energy Emergency didn't even exist before. Now it is filled, with very great competence, we feel.

It would seem that following through with some of the questioning, I understand that has been done by Senator Cohen, that it would make commonsense to have something strategic in our country like naval bases or missile silos, that you want to avoid putting all of our eggs in one basket. We seem to have followed this strategy in many cases. I wondered if you feel that this is wise.

I don't know if you can see this clearly with the light there. This is just an example of the way our oil pipeline network is now being placed. You can post that

I wonder if you feel, or could you comment on what you feel the strategy ought to be in the placement of our strategic reserves?

Mr. VAUGHAN. Senator, if I go back, predating myself, I will try to state for you my understanding of the judgments that were made and then comment upon them. As I understand it, the decision was made after considerable study that the Strategic Petroleum Reserve should be located in such a manner as to be able to serve the bulk of the Nation's refining capacity rather handily and quickly, and that it should be located in such a manner that it could cheaply store, with security also as a factor that was considered, oil for long periods of time.

After a number of options were reviewed, what was settled upon was salt dome storage, which I personally believe has a very high degree of security by the very nature of the salt dome since it is essentially invulnerable—it is below ground, and about all you have is a wellhead that is on the surface and vulnerable. The storage sites were located in the gulf coast region. They were located there primarily because the system of pipelines that radiate to the Nation's refinery base emanate from the gulf coast region.

The Strategic Petroleum Reserve is now located at five separate sites, so in a sense, we do not have all the strategic reserve eggs in one basket. They are in one region of the country for the reasons I mentioned. I don't think that poses a serious threat in itself.

However, we are revisiting that question as to whether we should disperse the locations in the future. As I mentioned, Senator Warner has recently communicated with me directly on that subject. I am pursuing that subject at the moment as to what would be involved and, of course, in any of those types of decisions, we are trading costs and benefits. Even in this business of security, of course, as you well know, sir, you must do that.

How many dollars of security or how much do you buy for your security dollar? The other thing I will say is, we do have the sites secure in the sense that they are fenced, lighted, and manned with armed guards. They are not what I would call hardened sites, and I do not believe that we could economically justify hardening these sites. We have had an experience of a fire at one of them, and one of the things that it confirmed was the judgment about vulnerability of salt storage.

While it was a very serious fire, we actually lost very little oil. It would seem to me it would be very difficult for saboteurs or terrorists to permanently, for any length of time, deny the Nation of our strategic oil storage.

To comment for a moment about the location of our oil refining capability, it is true that much of it is located in the gulf coast region. It was located there, I think it is fair to say, based on economic considerations rather than national security considerations, and certainly that poses a higher degree of vulnerability.

How we should correct that situation or even if it is correctable, frankly, we are looking at the problem. I don't know the answer to that. It will be a formidable task requiring many, many dollars to disperse things like refineries, tank farms, and loading docks.

Senator **Percy**. This area that is shown here is in Louisiana. What proportion of our Strategic Petroleum Reserves would be located in Louisiana in that area?

Mr. **Vaughan**. I will ask Mr. Furiga to specifically identify all the sites and their relative storage sizes quickly for you.

Mr. **Furiga**. Senator, we have four storage sites in the State of Louisiana. Two are in the western part of the State near the Texas border, and two are in the eastern part of the State. One is up near Baton Rouge. The other is all the way down the coast. The name of the site on the coast is Weeks Island. That particular picture which you showed is in the St. James area on the river. That is where our marine terminal is. Our marine terminal at St. James feeds two storage sites—we have pipelines running down to Weeks Island, and we have pipelines going up to the site near Baton Rouge which I mentioned is Bayou Choctaw.

The great number of tanks in that photo are Capline tanks—they are commercial tanks. Our docks are the two docks in the top of the picture, and our tanks are the tanks at the top of the picture, 6 tanks, 2 million barrels in capacity. They are surge tanks.

After the tanker off-loads into those tanks, it is put in the pipeline and sent to the salt cavern at Weeks Island or Bayou Choctaw. We do also have the one site over in Texas on the coast around Freeport, Tex. So we have five storage sites and one marine terminal, Government-owned marine terminal site, which are pretty widely dispersed throughout the gulf coast area.

Senator PERCY. I flew in yesterday morning from Germany in a C–5A. I was impressed with how many C–5A's that we had concentrated on one field. I discussed with the commanding officer there the dispersal plans they have with Early Warning. They can disperse those planes very, very rapidly, and they would under ordinary circumstances. This is a lot harder to disperse.

What, in your judgment, is the value of paying a premium for security? I know there are some economies in concentrating heavily in some areas, but have you thought through the cost-effectiveness of the extra cost of security that would be provided by dispersing our Strategic Petroleum Reserve somewhat more into other parts of the country?

Mr. FURIGA. We have not looked at that particular cost aspect of dispersing the reserve, but as we discussed prior to the hearing, we have completed a classified study on the reserve as it is now, the five storage sites and the marine terminal.

The basic conclusion is that while we do have the industrial type of security, as Secretary Vaughan mentioned, the fences, the guards, the lighting, we do have also some sophisticated equipment installed at our sites about which I cannot go into in detail, but we do have a level somewhat above the industrial security level that you would normally find.

And they are underground—that is probably one of the greatest security advantages that we have is that the caverns are underground.

Senator PERCY. Did you say that you do have a study underway as to whether or not dispersal is a feasible thing?

Mr. FURIGA. I said we have not looked at that.

Senator PERCY. You do not, then.

Do you think such a study would be feasible? We would certainly benefit. I think, tremendously from it and would like to share in the results if you could undertake such a study.

Mr. VAUGHAN. I mentioned in my remarks, in answer to an earlier question, that we do have underway such an inquiry. Whether it will be as formal as "a study" is another question.

What we intend to do is to try to estimate some cost of dispersal so that we can respond to you gentlemen as to what the price tag for dispersal might be.

That is exactly what we are trying to do with that effort. That is what I meant by the term "revisiting" this question of dispersal.

Senator **Percy**. Yes. It would certainly seem to make good sense to concentrate on decentralization as one of our options for the future and to study that. If you would share with us whatever conclusions you come to, we would be most interested in that.

One other way of doing it, of course, is an old subject of mine, solar energy, and alcohol fuels.

In my last trip to Israel in December, I noted with great interest that they are solar energy conscious probably because of the fact that they could be cut off or embargoed. I was conscious of the extensive use in Israel, as you fly by air—you don't see it at home—of not just the random use of solar energy in one form or another. There is a solar grid on every single housetop, it seems. Alcohol fuels in Brazil is used as a matter of policy. They have really become less dependent on imported petroleum through production of alcohol fuels, so it appears that two countries have really concentrated on the use of renewables and have done something to lessen their vulnerability to foreign influences outside their control.

One of the reasons solar energy is often uneconomic is that it is too dispersed. But from a security point of view, that would seem to be a very plus feature about it. Alcohol fuels may be able to make a farming community continue to function even if all other fuels are cut off.

The ethanol can be produced locally. It can be stored locally, and it can be consumed locally. That is one of the great values, I think, of that approach.

In past hearings on this subject that the Governmental Affairs Committee has had, we have discussed those aspects of it. New additives may soon allow ethanol to be used in diesel tractors, for instance.

In the event of a truly severe emergency, I am sure we will look favorably on solar energy and alcohol fuel; for that matter, other forms of renewable energy.

Secretary Vaughan, could I ask you to look into the emergency applications of fuel alcohol, including its storage, and report back to this subcommittee?

Mr. **Vaughan**. Yes, sir. We will look into that in conjunction with the other elements of the Department that have directed responsibility for alcohol fuels. The contribution, I think, we can make in my office is to look upon it as you indicated, from a security point of view.

We will do that and report back to this subcommittee at a later date.

Senator **Percy**. I appreciate that very much, indeed, as your office reviews the emergency or national security implications of the energy research now threatened by some budget cuts.

I have been busy for 3 days slashing unnecessary budget items, but I do think, as I told the National Science Foundation the night before last, that there are many areas where we are cutting research and development that is really tomfoolery. We would cut off our future, if we don't continue those things, and I will fight for every possible moneys that we can get that will help insure the security of this country and help us move dramatically toward alternate uses of other fuels.

We look forward to working very closely with you on that.

Thank you, very much for your testimony. There may be other questions that would be submitted for the record, and we will keep the record open for that purpose.

Thank you.

[The prepared statement of Mr. Vaughan follows:]

PREPARED STATEMENT OF WILLIAM A. VAUGHAN

Mr. Chairman and Members of the Subcommittee:

I appreciate the Subcommittee's invitation to discuss "energy resiliency." We have had an opportunity to meet with members of the Subcommittee's Staff to discuss this subject on several occasions and share your concern with the importance of this topic. As I will discuss, we at DOE believe that we have underway several projects which address these issues in a way which will help assure the viability of our national energy system.

Over the last several months, I have presented extensive testimony concerning various aspects of the Department of Energy's energy emergency preparedness programs. To a large degree, the focus of prior Congressional hearings has emphasized the Nation's ability to deal with disruptions of imported crude oil.

The focus of today's presentation, however, is on the resiliency of the Nation's energy supply and distribution systems to physical disruptions caused by major accidents, natural disasters, sabotage or terrorism.

Based on the studies and reports which have been done in the past, and on recent work done by the Department of Energy in conjunction with other Federal agencies, it is our preliminary view that the Nation's major energy systems have a significant degree of resiliency. For example, a recent Department of Energy report on storm-related electric power outages discussed the electric utility industry's ability to restore service to their customers quickly after severe storms. Electric utilities also have proven to be quite capable of substituting for electric generation resources that become unavailable for unexpected reasons. Another example is the natural gas industry's practice of storing reservoirs of back-up natural gas supplies in underground storage and LNG and other supplemental gas supplies.

But the fact cannot be ignored that domestic energy systems such as oil or gas wells and pipelines, nuclear power plants and conventional electric generators could become targets of unexpected disruptions, including sabotage. With this in mind, and because energy is so critical to national welfare and security, DOE is presently involved in a project assessing the vulnerability to terrorism, sabotage, and accidents of the electric utility network, natural gas and petroleum pipelines (including the Strategic Petroleum Reserve and the Naval Petroleum Reserves distribution systems) and other parts of the national energy system.

Rather than attempting to systematically examine every facility, and part of the energy system across America that might be vulnerable to various energy disruptions, DOE is following a case-study approach. The overly-detailed approach would not only be costly and time-consuming, and potentially would place an unnecessary information gathering burden on private industries and other organizations, but it would also duplicate unnecessarily many of the responsibilities of other Federal and state agencies and the private sector. Accordingly, DOE is undertaking a selective case-study vulnerability assessment program. The general approach of this program is to examine a number of carefully selected case studies that we have chosen because they are most illustrative of the ranges of possible vulnerability disruption problems.

Briefly stated, our objectives are to work, in conjunction with the Congress, other Federal and state agencies and appropriate elements in the private sector to:

- Identify and assess key energy vulnerabilities;
- Develop proposals as needed for reducing these vulnerabilities and report on the state-of-the-art on corrective measures;
- Encourage the appropriate organizations to take actions that will reduce the risks and vulnerabilities; and
- Prepare to respond appropriately if events occur that are beyond the resiliency of the energy system.

The program is being managed by the Department's Office of Energy Emergencies, with assistance from other Offices within the DOE. For example, the International Affairs Office is a source of intelligence information, the Defense Programs Office provides expertise on the sabotage/terrorism threat, and the Office of General Counsel assists in reviewing the responsibilities and authorities of various agencies for dealing with sabotage activity and disruptions generally.

Also, the DOE staff is coordinating its effort with the Department of Defense and FEMA, and with relevant intelligence agencies. Equally important, these studies are being coordinated closely with the appropriate energy industries, and with other key private-sector organizations.

A cooperative assessment effort is essential in order to develop a balanced, technically sound understanding of these problems, and to reach a consensus on what measures, if any, should be taken.

A primary concern in such an undertaking is the protection of sensitive information. Extreme care must be taken to avoid producing a "blueprint" on how to disrupt energy supplies, and we are taking every practical precaution to avoid creating such a "blueprint," including the use of national security classification.

The first priority of the Department's program is to assess the vulnerability of the United States' military capability to major acts of sabotage against domestic energy systems. The program's focus is on defense energy needs first because it is illustrative--it is expected that what we learn in examining resiliency of energy systems serving defense facilities will be applicable to our review of the energy vulnerability of key elements in the private sector.

Although the primary concern of the program at this point is energy disruptions caused by deliberate hostile acts, we also plan to examine the resiliency of key facilities to disruptions caused by natural disasters or accidents that are sufficiently severe to have a serious national impact. Moreover, DOE's program does not deal with incidents normally handled by industry or by local authorities--such as vandalism, storms, or equipment failures. Industry appears to have an excellent track record in dealing with such events, and there does not appear to be a need for any extension of Federal involvement.

The electric power portion of the DOE study program is well underway. The DOE staff has coordinated closely with the Defense Department to identify military installations and defense industrial producers that cannot operate without commercial electric power, and whose disruption during a period of military activity could significantly impact our combat readiness.

A few case studies have been conducted of critical military bases selected by the Air Force. There has been excellent cooperation from the operational personnel at these bases and from the technical staff of the electric utilities serving them.

The DOE staff is reviewing previous incidents of sabotage against domestic power systems, determining the kinds of sabotage that could cause disruptions, and assessing the ability of the industry to secure critical facilities. Work on the electric power study has not progressed far enough to permit the drafting of definitive conclusions, but I can offer three general observations which I believe are important:

First, one cannot conclude that a threat to national security necessarily exists simply because the power system to a defense installation could be interrupted. It's quite possible that a moderately long power outage at a particular installation might cause no discernible impairment of actual combat capability. With help from the Defense Department, DOE is trying to estimate the tolerable duration of outages for each of the case studies. These estimates, combined with the examination of the physical vulnerability and restoration capability of the utility, will yield a basis for estimating the vulnerability of actual military capability to power disruptions.

Second, it is important to consider the structure of our defense establishment, and the manner in which its energy needs are supplied. The Defense Department has a long-standing policy of avoiding excessive dependence on any single defense base or on any single industrial supplier. The relatively few facilities that are unique and time-urgent, such as command centers or strategic forces, usually have on-site primary or back-up power supplies. Even at facilities that do depend critically on commercially supplied energy, there is some tolerance for interruptions of a moderate duration. This means that some time is available for the supplying utility to restore service before a measurable impairment of military capability could occur.

Third, it is important to recognize the ability of supplying utilities to restore power. As I indicated at the outset, modern electric power systems are generally "resilient." There are a large number of powerplants, so no single one is critical. There are many alternate transmission and distribution routes. The utilities have large repair forces, and they maintain inventories of almost all replacement parts, except for certain very large or unique items. The electric utilities also have standing arrangements with neighboring utilities to share production and repair resources during emergencies. Finally, during contingencies they can resort to load-shedding, or can even break their system into separate operating regions--called "islands"-- so that priority loads can be served even when the system is badly crippled.

The DOE natural gas system vulnerability assessment project is just beginning. It will first be necessary to determine if there are critical defense facilities that cannot tolerate an interruption of natural gas supply. If not, the focus will be on the vulnerability of the general economy to sabotage or terrorism against the gas supply system.

The natural gas system, particularly in the northeastern states, at first glance, does not appear to have as much redundancy of sources or routes as the electric power system. It depends on a small number of major transmission pipelines. Also, there are certain segments of the gas pipeline system that may be quite vulnerable to concerted sabotage effort.

On the other hand, the owners of gas transmission and distribution facilities have a strong interest in providing uninterrupted supplies and service and have taken steps to assure security. Gas interruptions may be less disruptive than electric power interruptions because of gas storage, and because many major gas users can switch to alternate fuels. Also, during much of the year, pipelines operate well below capacity and could probably tolerate the loss of a few facilities (e.g, compressor stations). Finally, gas is simply not such an all-pervasive energy form as electricity. For example, typical gas furnaces cannot operate without electricity.

The DOE petroleum system vulnerability study is still in the planning stage. It will focus on the Alaska pipeline and on the system for distributing oil from the Strategic Petroleum Reserve. It is also expected that an examination of other selected pipelines, refineries, and port facilities will be performed. DOE may also look at the potential contribution of alternative liquid fuels, such as methanol or ethanol.

The ability of suppliers and consumers to store crude oil or petroleum products will, of course, have an impact on any assessment of vulnerability to sabotage against the delivery systems, and we will certainly look at this issue in the context of our overall study.

In addition to these projects, DOE has investigated a number of other areas of energy resiliency, and is continuing some of these efforts at the present time. For example, we have looked at the vulnerability of nuclear power plants and related facilities, security and vulnerability onsite at the Strategic Petroleum Reserve and the Naval Petroleum and Oil Shale Reserves, and selected issues relating to transportation modes such as waterways and railroad systems.

I do not want to give the impression that we are prejudging the resiliency of the Nation's energy system against acts of sabotage or other disruptions. In a serious case, the potential exists that the general population might suffer some level of hardship even if defense facilities are kept operating. We need to know more about the range of possibilities which might occur, and potential levels of hardship which might be experienced.

Let me reassure you on one more point. We recognize that the owners of energy facilities in the private sector have a strong interest in providing a reliable, resilient and secure energy supply system. This interest in avoiding disasters on the part of the private sector is a vital aspect of any overall security system.

In conducting our studies, we in DOE intend to respect private sector prerogatives and avoid any hint of harrassment or suggestion that the government alone is concerned about security.

You can be assured that the Department of Energy, and the Administration, take the question of resiliency of the domestic energy system very seriously, and we are vigorously examining the resiliency issue within the parameters which I have described above.

This concludes my remarks. I would be pleased to respond to any questions which you may have.

Senator **Percy**. I would like to ask our next three witnesses now to come forward.

We have another vote on. We are going to be plagued by this all morning, I am afraid. So I would appreciate it very much if Dr. Robert Kupperman would take his place with us here, and also, at the same time, having Amory Lovins come forward as well.

Dr. Kupperman is the executive director for scientific and technical affairs at the Georgetown Center for Strategic and International Affairs in Washington. You are an expert, among other things, on political terrorism and have advised the governments of the United States, Europe and the Middle East on this subject, and have directed the transition effort for the administration at the Federal Emergency Management Agency.

During the first of your comments, I wonder if you could comment on Secretary Vaughan's testimony. We would appreciate that very much, indeed. We are going to welcome Amory Lovins and Hunter Lovins having worked as a team on energy and resource policy.

Both of you are, I believe, currently visiting professors at Dartmouth College in Hanover, N.H. That takes me back to my days of navy training on the Dartmouth campus where the coldest winter in history was recorded. It was 22° below zero at 6 o'clock in the morning. I hope it has warmed up some since then.

Mr. Lovins was trained at Oxford University and the University of British Columbia. He has published 11 books and has served on the Energy Research Advisory Board of DOE. Mrs. Lovins is an attorney who has coauthored three books with her husband. One of these books entitled "Brittle Power: Energy Strategy for National Security," addresses many of the points we are discussing at this hearing. They are both eminently qualified to be with us.

We are delighted to have your testimony.

Dr. Kupperman, if you could go right ahead, I would then ask you to just continue when Senator Cohen returns so that we can try to go forward without interruptions.

If he doesn't get back in a couple of minutes, I will have to recess this hearing to catch that vote.

TESTIMONY OF ROBERT H. KUPPERMAN, EXECUTIVE DIRECTOR FOR SCIENTIFIC AND TECHNICAL AFFAIRS, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES, GEORGETOWN UNIVERSITY, WASHINGTON, D.C.; AND AMORY AND HUNTER LOVINS, HENRY R. LUCE VISITING PROFESSORS, DARTMOUTH COLLEGE, HANOVER, N.H.

Mr. **Kupperman**. Thank you, very much, Senator.

First of all, I thank you for inviting me. I applaud Secretary Vaughan and the administration generally in pursuing long neglected vulnerability of our energy distribution systems.

The subject has been reviewed in various studies regarding the vulnerability of the electric power grids as well as the gas-oil pipeline.

I have become concerned that we have not done nearly what we need to protect the energy infrastructure of the United States. Yet, studies of energy distribution are not enough. We need to study comparable problems of transportation, data management, and communication, as well.

Moreover, we need to stimulate the synergistic effects and dependencies of these systems with the energy transmission issues presently under study.

Having led the FEMA transition over a year ago, I found that that agency had done little or no contingency planning. Louis Guiffrida, now Director of the Agency, in my view, has inherited an appalling mess.

Senator PERCY. I am going to have to interrupt you, I am afraid. I have just been advised unless I get on my horse, I will miss this vote down there, and it is an important one. We will just recess for a couple of minutes until I get back or Senator Cohen returns.

[Brief recess.]

Senator COHEN [presiding]. The committee will come to order.

Dr. Kupperman, I believe you were at the beginning of your presentation. Why don't you proceed?

Mr. KUPPERMAN. Thank you, Senator.

As I said, I led the FEMA transition somewhat more than a year ago. I found at that time the agency had done little or no decent planning, virtually for anything. Louis Guiffrida, who has been appointed Director of FEMA, in my view, is a conscientious and thoughtful person. He has inherited an appalling mess. Were the vulnerability of power systems to mechanical failure, disaster and accident not problem enough, the effects of sabotage and terrorist attacks, in my view, could prove truly damaging.

Imagine, if you will, failures of pipelines at refineries or at electric power stations affecting major metropolitan areas for as much as several weeks. Our electric power distribution systems must be delicately balanced with other dependent networks, including fuel distribution.

We must be quite careful. The sabotage of power systems may create cascading effects measured in terms of other nonvital energy systems.

As far as I know, these phenomena are little understood. Thus, we need to examine the adequacy of the civil emergency preparedness. For example, how would we cope as a country with a cluster point of people denied heat, power, and adequate shelter and food?

We are a long ways from having decentralized, self-sufficient enclaves as have been thoughtfully espoused by Amory and Hunter Lovins. We need to find solutions, including hardening various choke points, stockpiling key components and redundancy.

Here, FEMA's industrial mobilization, crisis management and counterterrorism studies could be useful if combined.

International terrorism is becoming a serious problem. Increasingly it has emerged as a form of surrogate warfare. Terrorist warfare has a media effect of great proportion, when the object of television and the printed media. The terrorist's objectives are often governmental disruption, many groups having lost sight of their initial ideological goals. Surprise and adaptation are necessary components of the terrorist threat. The media becomes easily bored with skyjackings and embassy takeovers.

The new targets needed by the terrorists must maintain their popular appeal. They do not generally kill excessively. Leverage is their end, disruption of the victim government. Attacks upon the energy infrastructure have occurred in the past and will occur in the future in my view.

For example, at a time shortly before the last Democratic National Convention, the one in which then President Jimmy Carter was renominated, the police authorities were lucky, and they raided a safe house and found the detailed descriptions of the New York State energy grid and the electrical power supply system of Madison Square Garden—their intent of disrupting the electoral process.

Senator COHEN. There was no hint of Republican involvement in that? [Laughter.]

Mr. KUPPERMAN. No.

Terrorist organizations are mutating. They are now getting highly sophisticated. They are beginning to get technical talent among their ranks.

There are new sources of foment as well in the United States. Many believe that a newly disenfranchised lower middle income group has arisen. The summers of 1982 and 1983 may yet prove painful.

Terrorists may use civil disobedience to amplify their effects. I, of course, have no crystal ball, but none is needed to inquire about the security measures thus far taken to protect the critical site of our security.

That is the end of my statement.

Senator COHEN. Do you remember what took place several years ago—and I don't recall the specific incident—but there was a shortage or shortout in Baltimore?

As I recall, the National Guard was called in to try to restore some order. It was for a very brief period of time, and, yet, the threat of looting and chaos that was looming over that city required the calling out of the National Guard.

Are you familiar with that?

Mr. KUPPERMAN. Yes. Also, I think it was around 1977, New York was blacked out, and in that evening—that 24- or 26-hour period, I cannot recall which—I think 3,300 arrests were made for looting.

I think that is what had happened; there were relatively minor failures. While I don't, in any sense, accuse the utilities of malfeasance or neglect in these matters, the risk of catastrophic failure, not lasting forever, by any means, but, say, for several weeks, could create an enormous strain upon the United States, one which I don't believe we can afford.

Senator COHEN. Mr. Kupperman, I think there is some merit to what our first witness, Secretary Vaughan, was suggesting. I think he was suggesting we ought not to be so detailed or so concerned that we establish a self-fulfilling prophecy. That is a concern on his part and on the part of other people.

It seems to me that we ought not to go to the other polar extreme and not have at our hands, at least, some sort of prudent planning.

It is not to establish a blueprint of citing those installations that might, in fact, cause an eruption in the grid system, but you can pick up a novel in any store that can give you a blueprint as to how to achieve the kind of disruption that terrorists would seek to achieve.

I can recall reading one in 1975, 1976, "Whisper of the Ax", by Mr. Richard Condon, who also wrote the "Manchurian Candidate," gave a very detailed plot involving how terrorists could, on the eve of our bicentennial celebration, cause enough disruption so as to create chaos in our streets.

Mr. KUPPERMAN. I don't think you need the problems of denial to witness the self-fulfilling prophesies that are happening. We are entering a world, in my view, where conventional forms of warfare are too expensive; and the costs, measured in terms of the risks, of using nuclear weapons are horrendous.

Surrogate warfare, including terrorism, is going to be, in my view, the prevalent form of warfare of this decade.

Senator COHEN. Before you go ahead, you said that it is appalling what we have done so far.

Mr. KUPPERMAN. No: I did not. I said that at a time——

Senator COHEN. He took over an appalling situation.

Mr. KUPPERMAN. Guiffrida took over an appalling situation.

Senator COHEN. Is it less appalling today than it was?

Mr. KUPPERMAN. I do not know what Mr. Guiffrida has done. But I am familiar with him as a fine individual, and I know he would have done all that can be done in this short period of time.

Senator COHEN. What is your recommendation, specifically?

Mr. KUPPERMAN. Specifically, regarding the issue of energy transmission. Clearly, it is part of it. If you want to keep the amateurs out of the business, terrorists, particularly the more amateurish ones, do not attack hard targets. I think they can design teams, military teams up to as many as 15 people, going in lots of 2 or 3 apiece, highly well trained, paramilitary experts carrying, for example, R-PG-7 rockets that are sufficient to do an awful lot of damage.

Again, it is hardening, it is redundancy, it is re-examining the U.S. strategic military stockpile objectives. Maybe we need to store as to traditional raw goods, intermedial items such as large transformers.

I don't really want to go into any detail because I don't think in an open hearing that it is well advised.

Senator PERCY. Dr. Kupperman, I would like to ask you a question just about the general nature of this kind of a hearing.

There are those who feel that this is a subject better left undiscussed; that it might put ideas in people's minds, even putting maps up of some of our sensitive areas and discussing them might put ideas in people's heads.

I don't happen to think or agree with that philosophy. I would appreciate your reactions to it. I don't think you can sweep this thing under the rug. It would seem to me any group of people, any nation, any group of terrorists, whoever it may be, whatever their motive, that pose a threat to our energy system would be well-financed, sophisticated, well-armed, knowledgeable in intelligence matters and are not going to learn anything from our hearing, I imagine.

This isn't a business generally for amateurs, for the amateurs or mad men really pose the real threat.

What we can do is improve our preparedness by addressing this issue in the open, I think, and focusing on the real problems that we face.

I would very much appreciate, Dr. Kupperman, your own appraisal of that as to whether it is a good idea to orbit this, put it out in the open, face up to it, talk about it?

Mr. **Kupperman**. Senator, I admire and applaud your wisdom in conducting this hearing. The subject has been far too long hidden in the closet. Denial is never helpful in my view.

In fact, for example, when the New World Liberation Front attacked Pacific Gas & Electric over 70 times, that is not a self-fulfilling prophecy.

I think the American public has got to be made aware of the costs it will have to, in some way, bear. It is a national security question. It is no longer just a matter of testing the domestic issues that can be easily swept under the rug or left to a local law enforcement authority as the ultimate measure of success.

Senator **Percy**. I wonder if, Professors Lovins, you could address the same subject. How do you feel about this subject? Is it one that should be fully out in the public arena for discussion?

Mr. **Lovins**. We feel, Senator, the only thing more dangerous than discussing this subject is not discussing it, because the energy system is extremely vulnerable and is becoming more so.

Terrorists already know that. We feel it is very much time that the public and our political leaders found out about energy vulnerability and what to do about it. It is, clearly, important not to provide a cookbook, and in our own work, for example, we were very careful about that. We sent the manuscript to upwards of 50 outside reviewers and went through a formal Government classification review.

Senator **Percy**. Do you have anything to add, Mrs. Lovins?

Mrs. **Lovins**. We feel that because there is some good news on this subject, because there are very concrete things that can be done, not just by Government, but by individuals and communities and States, that the issue needs critically to be discussed, and that despite the risk of giving someone an idea—which, as the Senator said they could easily get at the neighborhood bookstore—we feel that the matter needs to be vigorously discussed in the public arena, not only so that people know what they are facing, but so that they know what they can do about it, as individuals and as communities.

Senator **Percy**. The question I put to Secretary Vaughan, Dr. Kupperman, on the security of our energy systems and the centralization of it where we have them concentrated so heavily is one that I would like you to address in the broadest way you can.

We are going to live with this situation until the day is economical for decentralized system, like when solar cells, for instance, become available. In the meantime, we seem to be compounding our vulnerability in a few vital areas. We have concentrated our Strategic Petroleum Reserve in a few massive storage sites. These places are well guarded, but all we have to do is figure out what would happen if a few missiles inflamed those vulnerable areas and how fast we would lose our reserve. There aren't very many targets they would have to hit, and that is well known to them. They know exactly where they are. Experience shows that even the best defenses can be destroyed.

It would seem to me commonsense would dictate that we diversify our storage by spreading it around the Nation.

Do you propose putting all our eggs in one basket?

Is this applicable in this kind of a case? Why do we have all our eggs in one basket? Tens or hundreds of oil storage sites could be put out of commission with just one successful attack. The cost, obviously, is more to diversify, but in the end, if your purpose is real security, are we getting real security by just having it all available out in the open and concentrated that way?

Mr. **Kupperman**. Senator, it is obviously an issue of security versus economic loss; economy of scale is the question.

I certainly have not studied the cost-effectiveness issues. Clearly, you obtain increased security by increasing diversification, dispersion, if you will. I think that that has got to be considered, because I think one of the things that has happened is that the strategic reserves have never been looked at in the light of terrorism as a possible targeting mechanism.

As to the issue in nuclear war, this is also a question of the proliferation of MIRV's as to what can be or not easily done and what ends up as a Russian target for us.

Senator **Cohen**. It doesn't have to be MIRV's, does it, when we have a problem with the increased production of plutonium?

Mr. **Kupperman**. Are you asking me in my association with the weapons design business for an opinion?

Senator **Cohen**. No. I am suggesting it doesn't have to be a question of a nuclear attack upon the Strategic Petroleum Reserve. For example, a lot of hearings have been held now about the loss of special nuclear materials they cannot account for. They don't know where it is.

Mr. **Kupperman**. Are we still refering to the petroleum reserve or what?

Senator **Cohen**. I wasn't clear. With the increase of MIRV's, I didn't know what you meant by that.

Mr. **Kupperman**. I meant if you are dealing in a nuclear war setting, where actual combat targeting was occurring, just the proliferation of large numbers of comparatively small nuclear weapons would be sufficient to overcome dispersion.

Senator **Percy**. Dr. Kupperman, I understand you have lunch with Secretary Drew Lewis. Give him our best regards, our admiration. Tell him I am looking forward to presenting an award to him at Dumbarton Oaks in a few weeks.

Mr. **Kupperman**. Thank you, very much.

Senator **Percy**. We thank you very much for your thoughtfulness in being with us.

I wonder if before the Lovins give their testimony, we could have you respond to this same question on dispersal of our strategic reserves.

Mrs. **Lovins**. Dr. Kupperman, of course, identified the cost problems of dispersing the existing reserve. I think what we ought to do is step back a step and ask, "Why was the reserve created?"

It is, of course, an excellent concept. But if we sought to achieve the same end in a different way—say, as distributing alcohol fuels production capability coupled with a very efficient vehicle fleet, say 40 miles a gallon—you would achieve exactly the same end. You could run the vehicle fleet for a month on what is in the tanks of vehicles just running around. You could run the vehicle fleet for a year with the oil that is now "in the pipeline" from wellhead to gas pump, just because of the increased efficiency of these vehicles.

How can we achieve the greatest security? We ought not to confine ourselves to what we are presently doing and asking how can we remedy the deficiencies in that, but open the field up to all of the technical possibilities now before us.

Senator **Percy**. Yes, sir?

Mr. **Lovins**. The vulnerability of centralized oil storage depots was dramatically demonstrated when the complex in Salisbury, Rhodesia, was blown up. That was a great blow to the national economy. There has been a similar attack on the synthetic fuel plants in South Africa.

In this country we have created, in effect, the same kind of vulnerability in the Strategic Petroleum Reserve that troubles us when it occurs in the Persian Gulf. I think three skilled people could cut the pipelines, for a long time, without which that Strategic Petroleum Reserve oil cannot get anywhere in this country.

It seems to me we do need to disperse both our crude and our product inventories; but they are already dispersed in the "pipeline inventory." If we had a cost-effectively efficient vehicle fleet, that dispersed inventory would run it for a year. If we wanted to beef up the dispersed product storage, you have 10,000 old, now-defunct gasoline stations, many of which have tanks that are still usable.

If we go back and look at the economics, I think dispersal would be much cheaper than we might have assumed.

Senator **Percy**. I would like to insert in the record at the appropriate place the written testimony prepared for this hearing by Adm. Thomas Moorer, the former Chairman of the Joint Chiefs of Staff, supporting creation of a strategic alcohol reserve.

I think his testimony on that would be very valuable, indeed.[1]

If we could have your own testimony, the full text of which will be incorporated in the record, you can summarize it in any way that you see fit.

I would just like to add that you have done, in this field, what Ground Zero has done to alert the country on nuclear war.

You have really lit some fires. I haven't always agreed with everything you said. I compare our energy distribution system with that in a lot of other countries. We look awfully good comparatively speaking. So I have a little higher regard for our current energy supply system that you have.

I mean, it is one of the most efficient in the world, but our job is to make it better. The views that you have expressed have been extraordinary, particularly your last about which we are all grateful very much indeed.

We would be happy to have your testimony now.

Mr. **Lovins**. Thank you, Senator.

Our analysis published today, "Brittle Power Energy Strategy for National Security," shows in detail—though discretely—how and why America's energy system is vulnerable to disruption by accidents or malice, and how to design one that isn't.

Our energy system is, indeed, frighteningly brittle—enabling a few people to turn off three-quarters of the natural gas to the Eastern States for upward of a year, in one evening without leaving Louisiana. Or a small group could destroy a few domestic pipelines, causing worse oil shortages than a total world import embargo, and, as I said, making the Strategic Petroleum Reserve virtually useless. Or, Mr. Vaughan to the contrary, they could black out one or more of our three electric grids. Certain attacks or kinds of accidents could cause even more serious damage than these disruptions of energy supplies.

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[1] See p. 191.

Some could kill as many people as the nuclear bombing of a city. These are not just theoretical possibilities. We have documented recent attacks on centralized energy systems in 26 States and in 44 foreign countries. Those attacks are becoming more frequent and sophisticated.

Furthermore, the Nation's energy brittleness is deeply rooted in the highly centralized technologies on which the energy policies of successive administrations, particularly this one, have been based. Energy vulnerability has increased over the past decade through the unthinking expansion of energy technologies, even less secure than the foreign oil they were meant to replace.

In short, it seems to us that Federal energy policy poses a grave and growing threat to national security directly undermining the mission of our Armed Forces by making our Nation ever easier to turn off.

I am astonished by Mr. Vaughan's remarks on the resilience of the electric grid, to pick a specific case.

The features he describes—some ability to reroute power and stocks of minor spare parts—do not provide resilience at all. They are normal precautions against predictable kinds of accidental breakdowns. That approach both makes our day-to-day power supply technically very reliable and makes the grid prone to unforeseen major failures like the northeast blackout in 1965 and the New York blackout in 1977—of which we did a case study.

What Mr. Vaughan did not describe is the measures which make the grid vulnerable to massive prolonged failures. Those measures include not only stringent requirements of synchronism and continuity across the continent, but also a great overreliance on particular transmission lines, extra-high-voltage transformers and switch gear, AC/DC conversion equipment, computers, and above all, control and communications equipment without which the grid cannot operate.

Serious damage to these devices is easily caused. Spare parts for them are seldom stocked and often take months or even years to make. Certain attacks, especially on control systems, could destroy the ability to control whole regional grids, resulting in rapidly spreading chaos. Some kinds of attacks could cause simultaneous damage to all the hardest-to-repair components over a very large area.

I should also point out there is no mechanism for priority-load dispatching in an emergency, as Mr. Vaughan said. And merely maintaining power to defense plants would not guarantee a strong America if most Americans were meanwhile freezing in the dark in their own homes.

There is an alternative, however. Our analysis derived from biology and from many kinds of engineering the design principles of resilience. Applying these principles to the energy system would make it much more efficient, diverse, dispersed, and renewable.

Major failures, from any cause, would become impossible. Yet such an energy system would be faster and cheaper to build than the more vulnerable, centralized sources now in operation.

A resilient energy system is also a least-cost system. It would save Americans trillions of dollars.

Let me dwell briefly on the main elements of resilient energy systems, starting with efficient energy use. Higher energy productivity offers the greatest resilience per dollar invested—the "most bounce per buck"—because it not only replaces the most vulnerable sources like Mideast oil; it also makes failures more graceful and easier to correct.

If you live in a superinsulated house in Maine and your heating system fails in midwinter, you won't even know it for weeks. You will find out only because the inside temperature will slowly drift down from 72 to 55 degrees—but no lower, so neither you nor your pipes will freeze. Any point source of heat can then bring your whole house back back up to 72 degrees, such as your neighbors, or burning junk mail in a No. 10 can.

Senator COHEN. Sixty percent of the homes in Maine now use wood as a primary or secondary source of energy.

Mr. LOVINS. Yes, indeed. By using energy more efficiently, in other words, we can make our dispersed fuel stocks last long enough that we will have time to fix what is broken or to improvise new supplies, such as alcohol fuels or wastes.

As you pointed out, Mr. Chairman, renewable energy sources—now over 7 percent of total U.S. energy supplies—add to this more graceful, correctable failure. The inherent resilience of dispersed, diverse sources.

For example, in Holyoke, Mass., in the 1965 blackout, the power engineer was able to cut the city loose from the grid before the grid crashed and to run the city on a gas turbine. Not having to turn off the city paid off the capital costs of that powerplant in 4 hours.

A man on the northern Great Plains who powers his house with wind reported that he was watching the television news one night and saw that his whole areas was blacked out. He went outside and looked. Sure enough, all his neighbors' lights were off. So he watched the news some more to see when his neighbors' lights would come back on.

Two years ago in West Chicago, a filling station had just installed solar cells when a thunderstorm blacked out the area. That was the only station pumping gas that afternoon.

Many of us would like to be in this resilient position, and with modern renewable technologies, we can be—if they are hooked up right. That is not now required or even allowed by the rules most utilities set for interconnection with the grid. We have identified that problem and several other Federal policy areas where, without prompt action, much of the potential resilience benefits of renewable energy may be lost.

Yet renewables are already the fastest-growing part of our Nation's energy supply. That is very good for national security. In the past 3 years, the United States has gotten more than 100 times as much new energy from energy savings as from all expansion of energy supply combined. And of those expansions, we got more new energy from renewables than from any or all of the nonrenewables.

After a head start of 30 years and $40 billion in direct Federal subsidies, nuclear power now gives about half as much energy as wood.

We are approaching our millionth solar building. In short, a quiet kind of energy revolution is well underway: building a resilient energy system from the bottom up, not from the top down.

Consistent adherence to freemarket principles, especially to open and fair access to information and capital—without which no free market can work—would greatly help the thousands of communities and millions of individuals who are already doing the things we have recommended to do them even faster and better. We hope that your distinguished efforts. Mr. Chairman, and Senator Cohen, to advance the cheapest over the costliest energy options will be reinforced by the observation that those cheapest options are vital not only to our prosperity, but also to the preservation of our lives and freedoms. A least-cost energy strategy can simultaneously enhance our military preparedness, make it less necessary, and protect the individual choice and civil liberties that rank among our most cherished national values.

Thank you.

Senator PERCY. Thank you, very much.

I have just one question, Senator Cohen.

I generally agree with you completely that the decentralized energy technology is also connected to security. Your story about the powerplant in Massachusetts is an energy source that may not seem viable in normal times. It could really be a bargain in a shortage.

Last year, we asked the Office of Technology Assessment to conduct a study showing what energy technology could be brought into use during a shortage. The study is about now half completed. We would like to share that with you just as rapidly as we possibly can. Almost without exception, these will be decentralized systems. It may not look particularly attractive today, but they could make a major difference in any emergency. It will look like a bargain in those days, I think.

A local alcohol still is an excellent example. Do you see any new technologies or old ones, for that matter, which we might want to prepare today to use in some future shortages?

Mrs. LOVINS. One technology in particular that we think deserves the attention of the Department of Energy's research budget are the second-generation photovoltaics. That research effort was one of the few that could be shown to be cost effective now and have a large potential payoff. It is one of the real shames that that budget has been cut.

The Japanese are moving ahead rapidly with this kind of research. Sanyo recently invested about $50 million in a commercial plant to produce these second-generation photovoltaics. Japan plans. by 1985, to have nearly a million houses with photovoltaics. They will, by the end of this year, have 11 percent of homes equipped with solar water heaters. They are perhaps moving in this direction because of their experience during World War II when roughly 70 percent of their electricity was provided by dispersed microhydro, which proved militarily invulnerable, while the centralized power stations sustained something like 99 percent of the bombing damage.

If what we are after is energy in time of a shortage, then, certainly, I think, those renewable sources deserve great attention.

Our findings, however, are that they also deserve great attention right now because they save money and jobs. Many of our communities are spending something like 85 percent of their energy budget to buy imported energy, whether from Texas or Arabia. Many communities are bleeding to death trying to pay their energy bills. We are finding communities across the country moving rapidly toward a soft energy path as their means of revitalizing their communities and providing for economic growth.

A community such as Fairfield, Calif., was negotiating to get a semiconductor plant. The local utility said, "Sorry, we cannot guarantee you the power." So the semiconductor plant decided not to locate in that community. That angered Fairfield so much that they have now installed a municipal wind utility and are trying to attract wind manufacturers to their town so they can provide their own energy.

So, whether for economic development or national security in time of cutoff, we feel these cutoffs deserve our highest priority.

There are two things the Government can do to expedite this. One is to try to get rid of the barriers now in place—particularly the subsidies that make the more centralized, more vulnerable sources of energy appear to be cheaper when, at the margin, they are not.

The second is to provide as much information as possible to individuals and communities on what is possible; what can they do? The Department of Energy had a splendid Office of Consumer Affairs which was doing a very professional job of getting that information out to whoever wanted it. That Office is now shattered. It was perhaps our greatest loss in the new Department of Energy.

One of our strongest recommendations would be to reinstitute that office under the people running it previously and let it do its job of helping the free market work. The free market simply cannot work in the absence of that kind of information.

Senator PERCY. Thank you. I presume both of you would agree with me that we are still just scratching the surface in the area of conservation as a new source of energy?

Are you on the record of remaining with the Alliance to Save Energy?

Mrs. LOVINS. Yes, we are. It is extremely valuable.

Senator PERCY. I would really personally appreciate any little handwritten comments that you have that would come directly to me. I know that the late Senator Humphrey was such an inspiration to me when he, with his usual enthusiasm, dug in as cofounder of that 5 or 6 years ago.

I think we gave it a budget of $100 million a year. Now the Advertising Council has contributed $80 million with public television, radio, commercial television to promote that idea of conservation.

We are making bigger moves. I think it has contributed immensely to this huge reduction we have had in the import of oil. It has helped a lot.

Any ideas you have with that would help us very much, indeed.

Mrs. LOVINS. A brief comment on that: You have put your finger squarely on the cause of the oil glut. The reason we now have a glut is that our efficiency efforts have been working, but if we cease them, the glut will go away very rapidly. We have no choice but to pursue efficiency with all our heart. That is the way to cut off Saudi Arabia. If we want to stick it to OPEC, efficiency is what will do it.

Senator **Percy**. Thank you.

Senator Cohen?

Senator **Cohen**. Mr. Chairman, in view of that, it is all the more ironic that we have cut back in our budget priorities from those very resources which are most renewable, which are least expensive, which are most insulated from the taxes we have discussed today. We have cut back the budget on home weatherization, which I find almost shocking that we would turn our backs on the weatherization program and encourage the increased consumption of oil.

We have cut back the research on solar. We have cut back R. & D. on the so-called exotic alternative systems in favor of more money for nuclear power.

I have not been one to condemn the use of nuclear power. We have a nuclear powerplant in my State, and it provides a very useful source of energy in the absence of an alternative. But it seems to me if we are looking to the future in the kind of threats we are facing in a world that has become miniaturized by that technology, and with that miniaturization comes an enhancement of the danger of the threat to our survival, then we are simply proceeding in the wrong direction.

So when we have these options available, when they are so readily available—and it has been sheer economics which has forced the people of Maine to use wood. It is not because they want to. It has its own hazards. We have more fires. We have older people who cannot carry wood, but the sheer economic necessity of burning paper has forced people to go back to heating their homes with wood. That may ultimately prove much more beneficial in terms of their security.

What I want to ask the first witness, Mr. Chairman, is what happens if there is a Mideast war tomorrow or next week or next year and there is a cutoff of the supply of energy?

What happens if we don't have a petroleum allocation mechanism, which we don't have, which this administration is opposed to?

What happens to the people in the Northeast who depend, more than any other region, perhaps, upon oil from the Middle East?

What mechanism do we have to transfer oil to that region other than the marketplace?

The question I would like to ask is, do you think the marketplace really has an interest in transferring oil to the Northeast under those circumstances?

Mr. **Lovins**. Some of the components without which the major Mideast oil terminals cannot work would take 2 or 3 years to manufacture. Some of them can be made at only one plant in the world.

Our energy supplies, both imported and domestic, do, indeed, hang by quite a slender thread. But the longer term solution to that fragility can be well underway in a surprisingly few years.

We could, for example, more than eliminate all U.S. oil imports in this decade by improving the efficiency of our buildings and cars. We could do that before a new powerplant or synthetic fuel plant could deliver any energy whatever, and at a 10th of its cost.

Meanwhile, I fear, as Dr. Kupperman suggested, all we can do is contingency planning, stocking spare parts and so on. But the broader policy question before us is whether the energy policy of this administration is making our energy supplies more or less vulnerable.

I think clearly it is making them more vulnerable and expensive.

Senator COHEN. I appreciate particularly your response about the chairman's response. We went through this in an analogous situation. In debating our defense budget, it is whether we have one big ship or several little ones. It is the argument of security. Do we have offensive protection with one big one or with two smaller ones that are less capable and more vulnerable? It seems to me that is the same argument.

If we are just going to build several little petroleum strategic reserves, it doesn't really solve the problem, because you haven't dealt with the most essential part of that, which is the transportation.

If you have 10 petroleum reserve sites, it seems to me you don't complicate the problem if, in fact, there is an interstate line of communication which is easily capable of being sabotaged.

So it is not simply creating more of what we have got, but creating a different source of energy which, per se, inherently is less subject to that kind of vulnerable attack.

Mr. LOVINS. You are absolutely right, Senator. In fact, in our own analysis of exactly what would happen in a major oil cutoff, it appeared that the Nation might be better off stockpiling insulation and weatherstripping materials than stockpiling oil.

Senator COHEN. Thank you, Mr. Chairman.

Senator PERCY. Thank you both very much, indeed.

We have greatly appreciated having you and hearing your testimony today.

[The prepared statement of Mr. and Mrs. Lovins follow:]

UNITED STATES SENATE
COMMITTEE ON GOVERNMENTAL AFFAIRS
SUBCOMMITTEE ON ENERGY

HEARING ON ENERGY VULNERABILITY
10:30 AM, 21 May 1982

Prepared Testimony of
AMORY B. LOVINS and L. HUNTER LOVINS*

Over many decades, the United States has gradually built up an energy system that is extremely brittle--easily shattered by accident or malice. The Treasury is subsidizing the energy industries with over $10 billion a year to undermine the mission of the Armed Forces--by making it possible, for example, for a few people to shut off three-quarters of the natural gas supply to the Eastern states in one evening without even leaving Louisiana. Domestic oil systems are at least that vulnerable. Electric grids are even more so.

This grave and growing threat to national security comes not from hostile ideology but from misapplied technology. It is not a threat imposed on us by enemies abroad. It is a threat we have heedlessly, and needlessly, imposed on ourselves, by assembling complex, highly centralized energy technologies in ways that make them prone to sudden, massive failures with catastrophic consequences.

Energy vulnerability poses more than a military threat. It is also a political threat. Any vulnerability which greatly alters the power balance between large and small groups in society can erode the liberties and the trust which underpin Constitutional government. Energy vulnerability also threatens abrupt lurches backwards, by decades if not centuries, in our economic progress and standard of living.

Yet there *is* an alternative to brittle energy. Available, cost-effective technologies, organized on different principles than in the past, can actually make major failures of energy supply *impossible*, meet all the energy needs of a dynamic economy, and save Americans trillions of dollars. This conclusion comes from a detailed (but discreet) analysis of how and why America's energy system is vulnerable, and how to design one that isn't. Commissioned in 1979 by the Defense Civil Preparedness Agency, our report was released by the Federal Emergency Management Agency last November**. It is published today in an updated version rewritten for a lay audience†.

Energy vulnerabilities are frighteningly real. Terrorists around the world exploit them weekly. We have documented recent assaults on centralized energy systems in upwards of twenty-six states and forty foreign countries. These attacks are becoming more frequent, intense, and sophisticated.

Federal policy has not just ignored but *caused* this risk. For example, after the Arab oil embargo of 1973 and the Iranian revolution of 1979, our government promoted substitutes for foreign oil which were themselves at least as vulnerable. Through the misguided belief that any domestic energy source must automatically be more secure than foreign oil, most Federal programs have actually *increased* energy insecurity, in ways that are more subtle and less tractable. That process continues. The Department of Energy seems unaware that its favorite technologies are compromising national security, despite warnings from the General Accounting Office and from inquiries into the Trans-Alaska Pipeline.

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*Energy policy consultants; currently Luce Visiting Professors at Dartmouth College. A biographical sketch is attached.

**A.B. & L.H. Lovins, *Energy Policies for Resilience and National Security*, Final Report to CEQ (Contract #EQ9AC016) for FEMA (Contract #DCPA 01-79-C-0317), FEMA Work Unit 4351C, DTIC Accession #A108263, released 13 November 1981 by the Federal Emergency Management Agency, Washington, D.C. 20472.

†A.B. & L.H. Lovins, *Brittle Power: Energy Strategy for National Security*, Brick House Publishing Company (34 Essex St, Andover MA 01810), 21 May 1982, ISBN 0-931790-28-X, $17.95. Foreword by Admiral Thomas H. Moorer (USN Ret) [Chairman of the Joint Chiefs of Staff under President Nixon] and Hon. R. James Woolsey [Undersecretary of the Navy in the Carter Administration].

To be sure, imported oil is an urgent problem. It is also soluble: just raising the efficiency of buildings and cars could more than eliminate U.S. oil imports within this decade, before a power plant or synfuel plant ordered now could deliver any energy whatever, and at a tenth of its cost. We could save more oil (at a cost of a few dollars per barrel) by making efficient cars than Saudi Arabia gets from the world's biggest oilfield. But energy is more than oil, and energy security is far more than ability to keep the oil coming. Even zero oil imports would barely begin to reduce America's total inventory of critical energy chokepoints.

For example, the loss of three major domestic oil pipelines--each of which could be knocked out for more than a year by one person--could be more serious than a complete cutoff of oil imports (and could incidentally make the Strategic Petroleum Reserve all but useless). A few people can black out, for months to years, any of our nation's three regional electric grids. Certain attacks on natural-gas systems could incinerate a city.

These and worse disasters could happen through accident, natural cause, or intention, in ways too complex for any technologist to predict or forestall. Many basic features of today's energy system make it brittle. Fuel and power are hauled hundreds or thousands of miles from centralized, capital-intensive plants which require many scarce resources, including specialized skills and public acceptance. There is only limited ability to substitute fuels and change delivery systems. Grids and pipelines can maintain their synchronism and continuity only by computerized control and communication over great distances. Fuel distribution systems can be contaminated with noxious materials. Many supposedly independent energy systems rely on each other. Major repairs often need scarce crews and equipment, and spare parts that take months or years to get.

We have considered these matters both generically and in the specific context of liquefied energy gases, the oil and gas system, nuclear systems, and central-electric grids. Bipartisan Federal policy--which might be called "Forward, Lemmings!"--is *expanding the most vulnerable* systems: power grids with ever bigger stations and longer transmission lines, offshore and Arctic oil and gas, big pipelines, and synfuels. National coal policy aims to create in Wyoming a new, all-American Strait of Hormuz. Our nation is building an energy system fit only for a tranquil "technological paradise" in which everything works according to the blueprints.

Our research did not stop with the bad news; we sought and found remedies. From biology, and from the design of computers, warships, aircraft, reactors, and other devices, we derived some twenty design principles for *inherently resilient* systems in which massive failures are impossible or inconsequential. Such systems do not merely withstand stress, but emerge from stress more resilient than before. An energy system designed on these principles would be *more efficient, diverse, dispersed, and renewable*. This would make our nation far stronger and more secure. Yet the "premium" we must pay for the "insurance policy" of energy resilience, far from costing us money, *pays us* handsomely in both money and jobs, starting immediately. This is because a resilient energy system is faster to build, and cheaper both to build and to run, than the more centralized, vulnerable alternatives now in fashion.

The greatest resilience per dollar invested--the "most bounce per buck"--comes from raising energy productivity. Efficient energy use does far more than just replace the most vulnerable marginal sources, such as Persian Gulf oil. For example, if you live in a superinsulated house in Minnesota and your heating system fails in midwinter, you won't even know it for weeks. You'll find out only because the inside temperature will slowly drift down from 72°F to 62° or perhaps at worst about 55°. Such a house cannot get any colder than that, so neither you nor your pipes will freeze. Any point source of heat can bring your whole house back up to 72°--say, a neighbor, or burning junk mail in a #10 can.

Thus wringing more work from our energy can help us live better at lower cost while making energy supply failures more graceful and correctable. On a national scale, the half-filled gas tanks of a 50-mile-per-gallon car fleet would run them for a month. Dispersed oil inventories between wellhead and gas-pump would run the transportation system for a year--whereas now a major pipeline break can shut down a refinery in a few days. By using energy more efficiently, we can stretch our stocks, using them up so slowly that we have time to fix whatever is broken or to improvise new supplies (such as alcohol fuels from biomass wastes). This ability of efficient use to buy time is yet another powerful reason to use energy in a way that saves money.

Over the next few decades, renewable energy sources--now over seven percent of total U.S. energy supplies, and the fastest-growing part--can replace most of the vulnerable parts of the energy system. Renewable energy flows cannot be cut off and require little or no distribution system. Despite fluctuations with time and weather, well-designed renewable supplies can be more reliable and predictable than nonrenewables: we can predict sun, wind, and rain much better than we can predict reactor accidents, terrorism, or Saudi politics.

A few examples show the resilience of dispersed, diverse sources:

- When the power engineer in Holyoke, Massachusetts saw the 1965 Northeast blackout rolling toward him, he isolated the city from the grid and powered Holyoke with a newly installed gas turbine. Not having to turn off the city paid off the capital cost of that power plant in four hours.
- In 1980, a thunderstorm blacked out West Chicago shortly after DOE officials had opened a demonstration photovoltaic-powered filling station. That station was the only one in the area pumping gas.
- A man who powers his house with wind on the northern Great Plains recently reported that he was watching the TV news one night and saw that his whole area was blacked out. He went outside and looked: all his neighbors' lights were off. So he came inside and watched TV some more to see when his neighbors' lights would come back on.

Many of us would like to be in that position. And with modern renewable technologies, we can be, whether we're in the countryside or the city--but only if we change some rules. Today, most utilities require dispersed sources to be hooked to the grid in such a way that they cannot function without it. This is unnecessary and should be changed. We have indeed identified several neglected Federal policy areas where, without prompt action, much of the potential resilience benefits of renewables may be lost.

Efficiency and renewables are already the fastest-growing parts of our nation's energy supplies. Since 1979, the United States has gotten more than a hundred times as much new energy from savings as from all expansions of energy supply combined. Of those expansions, too, we have gotten more new energy from renewables than from any or all of the nonrenewables, despite subsidies biased more than ten-to-one the other way. After a head start of thirty years and $40 billion in direct Federal subsidies, nuclear power now delivers about half as much energy as wood. More megawatts of new generating capacity have been ordered from small hydro and windpower than from coal or nuclear plants, or both of them put together. We are approaching our millionth solar building. A quiet kind of energy revolution is well underway--building a resilient energy system from the bottom up, not from the top down. This vindicates the Jeffersonians, who think people are pretty smart and, given incentive and opportunity, can choose wisely for themselves. It also vindicates the true free-marketeers, who say that we can do many small, simple, accessible things faster through a decentralized market process than we could do a few big, complex things through a centrally planned economy on the Soviet model.

It does not, however, vindicate this Administration's policy that there is no need for Federal action--except to try to bail out a nuclear industry now dying of an incurable attack of market forces. A free market, after all, can only work by open and fair access to information and capital. Until the Department of Energy became a bastion of corporate socialism, it was making a good start on informing people of their opportunities, as DOE's Office of Consumer Affairs used to do; helping state and local governments to enable the market to work by clearing institutional barriers; abolishing (or at least equalizing) subsidies; and providing, as the Public Utility Regulatory Policies Act sought to do, a more competitive marketplace in energy services.

Today, Mr. Chairman, despite distinguished efforts by yourself and many of your colleagues in the Congress, most Federal policies are promoting the most expensive and vulnerable energy systems while stifling the cheapest and most resilient. As millions of individuals and thousands of communities seek to achieve energy security by their own efforts with their own resources--and to stanch the hemorrhage of energy payments out of their local economies--they are finding new barriers placed in their way by Washington. We hope our work will help to focus public attention on the national-security reasons, in addition to the obvious economic and social reasons, to reverse that dangerous course.

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BIOGRAPHICAL SKETCH OF AMORY AND HUNTER LOVINS

Amory B. Lovins and L. Hunter Lovins work as a team on energy and resource policy, consulting and lecturing in over fifteen countries. Currently Henry R. Luce Visiting Professors at Dartmouth College, they are joint Policy Advisors to Friends of the Earth, a U.S. conservation group.

Amory Lovins, a physicist, was born in Washington, D.C. in 1947. After two years each at Harvard College and at Magdalen College, Oxford, he became a Junior Research Fellow of Merton College, Oxford in 1969. He resigned in 1971 to work for Friends of the Earth, based in London during 1971-81. He is also Vice-President of Friends of the Earth Foundation.

Mr. Lovins received an Oxford M.A. degree by Special Resolution in 1971 and D.Sc. degrees *honoris causa* from Bates College (1979) and Williams College (1981). Twice Regents' Lecturer in the University of California (Berkeley, energy policy, spring 1978, and Riverside, economics, spring 1980), he was 1979 Grauer Lecturer in the University of British Columbia, and will be Distinguished Visiting Professor in the University of Colorado at Boulder this summer.

His clients have included a wide variety of international agencies; U.S., foreign, and state governments; industries; and financial institutions. He has published eleven books and numerous technical papers, and served in 1980-81 on the Energy Research Advisory Board of the U.S. Department of Energy.

Hunter Lovins is a lawyer, political scientist, sociologist, and forester. Born in Vermont in 1950, she received a B.A. degree from Pitzer College in political studies and sociology. Her J.D. degree from Loyola University School of Law (Los Angeles) was accompanied by the Alumni Award for Outstanding Service. Since 1975 she has been a member of the California Bar and a partner of Hirschtick & Sheldon in Los Angeles.

From 1974 to 1979 Ms. Lovins served as Assistant Director of the California Conservation Project ("Tree People"), which she helped to establish in Los Angeles and whose energy and environmental programs she developed. She has lectured and consulted widely; taught workshops for the University of Oklahoma, the American Association for the Advancement of Science, and others; and served in 1979 on the City of Los Angeles Energy Management Advisory Board.

Ms. Lovins has co-authored and edited many papers and three books: *Energy/War: Breaking the Nuclear Link* (1980), *Brittle Power: Energy Strategy for National Security* (1982), and *Least-Cost Energy: Solving the CO_2 Problem* (1982). The latter two describe research done under contract to the U.S. Defense Civil Preparedness Agency and the German Federal Environmental Agency respectively.

The Lovinses have won a 1982 Mitchell Prize for their analysis of how electric utilities can regain financial health. Their work is the subject of the 16mm film "Lovins on the Soft Path," now in the finals of the American Film Festival. They are building a solar house/bioshelter/research center in western Colorado, and will continue policy research there--on energy, water, soil fertility, and peace--as principals of the newly formed Rocky Mountain Institute.

Senator PERCY. We will combine our next two panels and would ask Don Handy, John Stevenson, Arthur Albertson, and Victor Maggio to please come forward.

Mr. Handy is president of the Illinois Alcohol Fuels Association.

Mr. Stevenson is legislative chairman of the National Corn Growers Association.

I have already mentioned the Commodities Surplus Disposal Act, which I introduced yesterday, and as Senator Alan Dixon is a cosponsor, plus seven other Senators.

Mr. Handy, as president of the Illinois Alcohol Fuels Association, representing 400 alcohol fuel producers in the State of Illinois, you are a former director of the Illinois Energy Commission, serving under Governor Walker and Governor Thompson. I would be pleased to hear your testimony, the full text of which will be incorporated in the record.

If it is at all possible, could each of you summarize so we could maximize our time for questions?

TESTIMONY OF DONALD G. HANDY, PRESIDENT, ILLINOIS ALCOHOL FUELS ASSOCIATION, SPRINGFIELD, ILL.; JOHN STEVENSON, LEGISLATIVE CHAIRMAN, NATIONAL CORN GROWERS ASSOCIATION, CIRCLEVILLE, OHIO; ARTHUR ALBERTSON, WASHINGTON VICE PRESIDENT, CHICAGO BRIDGE & IRON CO., OAK BROOK, ILL.; AND VICTOR MAGGIO, INTERNATIONAL REPRESENTATIVE, CONSTRUCTION DIVISION, INTERNATIONAL BROTHERHOOD OF BOILERMAKERS, IRON SHIP BUILDERS, BLACKSMITHS, FORGERS, AND HELPERS, WASHINGTON, D.C.

Mr. HANDY. Thank you, sir.

First of all, the Illinois Alcohol Fuels Association has a total of approximately 400 in our membership.

We do not have 400 active alcohol producers in the State of Illinois. I would like to make that point clear.

Mr. Chairman, on behalf of the membership of the Illinois Alcohol Fuels Association, which our membership consists of both large producers, medium-sized producers, and small producers, the producers with feedstock coming from corn producers coming from waste candy and other waste products such as bakery products and other products, these are the main producers of the State of Illinois.

I would like to take this opportunity to thank you for appearing before this committee. The fact that the State of Illinois can claim the lion's share of the national alcohol fuel production capacity is due, to a large measure, to the leadership that you provided in Congress and then also to our own farmers and producers in the State of Illinois.

We certainly appreciate that leadership that you have expressed.

Copies of my statement have been presented to your staff and to members of this committee. We are, indeed, happy to be here today to express our support on the legislation just recently introduced by yourselves and Illinois junior senator, the Honorable Alan J. Dixon, S. 2554.

This important measure, which has been introduced by a number of House Members, including Congressman Findley, deserve immediate enaction.

We do not want to put all our eggs in one basket, and S. 2554 disperses our eggs in a number of baskets.

This legislation offers the Secretary of Agriculture an important means of increasing outlets for surplus agricultural commodities. By providing the Secretary with the authority to accept bids from alcohol fuel producers of any size to process surplus commodities into fuel alcohol, this legislation is also important because it would direct the Secretary to retain title to the alcohol producers of these processes and to sell the alcohol fuel to the Federal Government.

Mr. Chairman, your legislation is important to the American Agricultural Community because it increases the flexibility of a badly needed new outlet that is provided which can assist the Secretary in the efforts to break the vicious vehicle of low productivity, overproduction, and costly Federal Government takeover of surplus stocks.

By starting with a gradual, manageable program, your legislation would provide the basis for a proven complement of the conventional approach to bulk grain trade and utilization.

The Department of Agriculture has recently released studies which underscores the need for more value-added processing of American agriculture commodities.

For instance, it is estimated that if only 10 percent of the $8.7 billion worth of corn exported by the United States last year was processed into wet milling processes for export, business activities would increase by over $7 billion, 165,000 new jobs would be created, and personal income in the United States would increase by $1.7 billion.

In summary, Senator, we would like to support this activity, support this legislation on S. 2554 and on behalf of the Alcohol Fuels Association from the State of Illinois, we would like to provide any support to you and other members supporting this legislation.

We feel that this legislation would be a step forward in establishing a national policy for alcohol fuels and in addition, a policy that was initiated by one of the former directors, Bill Holmberg, a couple of years ago, a policy that is very much graded toward alcohol fuel.

One lasting idea would be that to create an alcohol fuel—the alcohol fuels industry in the Nation needs some kind of Federal active coordinating alcohol fuels office which we don't have in the Federal Government today that is lending support, technology, and an information exchange through the producers or the potential producers out there in the States.

Thank you, very much, sir.

Senator Percy. Thank you, very much. Mr. Handy.

Mr. Stevenson, as vice president of the National Corn Growers Association, you have got 10,000 members nationally.

I understand you are also president of the Ohio Farm Bureaus Association.

Mr. Stevenson. That is right, Senator. Thank you.

Senator Percy. We have a vote on, again, regretfully, but why don't you try to summarize your statement, and the full text will be incorporated.

Mr. Stevenson. Very good, thank you.

We, too, salute you as being a watchdog over the alcohol fuels industry over the past several years and giving the whole industry the encouragement it has needed to continue on.

We thank you immensely for your perseverance.

The thing I think we would like to emphasize today is that as of 2 years ago, the national corn growers developed a policy that is very much in line with the thinking here on this legislation: That the excess commodities be converted to liquid fuels and be put into a strategic reserve.

Our concern was that the coproducts might cause an imbalance for soybean mills and other proteins. So my own thinking was that we offer a strategic reserve for the distiller industries, particularly those that could be formulated for human nutrition.

One thing, as a kind of a personal observation, is as we have looked back to the success of détente, the creative successful years have been when there has not been the scarcity of food in Eastern Europe.

Possibly one of the uses of the distiller grains as far as animal feed would be strategic reserves someplace, maybe through Public Law 480 or such, because we need to keep Europe dependent upon us.

This is going to keep us going, as we see it, and to keep this Nation going. Essentially, it is a defense. With those things in mind, Senator, we appreciate the opportunity for being here.

If there are any questions, we will attempt to answer them.

Senator PERCY. Thank you, very much.

Because our subject matter will be so different in our next panel, just one question briefly for each of you:

Mr. Handy, the legislation that I introduced yesterday would seem to me to be a cost-effective use for a converted fuel, because it can save taxpayers funds at both ends. We would reduce or eliminate storage or handling costs for storage of grain and likewise reduce the food bill to the General Services Administration.

Do you believe it might ultimately make sense to create an alcohol fuel reserve, perhaps even in Illinois, to supplement the Strategic Petroleum Reserve and how useful might this be for farm communities both now, as much surplus corn is sitting around, and in the event of an oil supply disruption?

Mr. HANDY. I was the allocation director for the State of Illinois during the last embargo. I can assure you that any time under the reserves at all that would go into our reserve system would be very appreciated, not only by the agricultural community, but by the entire State of Illinois or any other State.

I would make one suggestion: That these allocations storage considerations that we might want to consider is along the pipeline systems, and, of course, Illinois is in the hub of that whole pipeline system of the United States. But I could see a number of storage facilities throughout this Nation and throughout the State of Illinois along these pipeline systems.

Senator PERCY. Mr. Stevenson, we are certainly conscious of the Corn Growers ourselves and sharing with farmers the important income that corn generates; we can see the effect the economy has had now on the adverse conditions that we face in the farm community. Many of them have become financially in acute distress. On corn gluten feed, of course, we have been fighting very hard with the Europeans.

We have every day a battle on our hands to insure that our exports to Europe are protected.

Can you think of anything else that we could be doing to not only assist our agricultural community and farm growers, but also to help strengthen the national economy and national security interest?

Mr. STEVENSON. Certainly, Mr. Chairman, anything that takes a commodity out of the market—and we are cognizant of the fact that with each 100 million bushels that disappear, so to speak, or leaves the market, we could expect about a 12-cent-per-bushel increase for a bushel or corn. That certainly would be welcomed at this stage.

I think on a long range aspect, one of the most disastrous consequences of the failure of alcohol fuels on farm production, as well as in the larger class, will be that there will not be a system to fully utilize biomass fuels that are farm produced and are not economically transported to a refinery much over 10 or 15 miles away.

I think agriculture will miss a grand opportunity to contribute even more to sociey.

Thank you.

Senator PERCY. I thank you, very much, indeed.

Gentlemen, I know that you have time schedules. I would be happy to have you stay, but our final witnesses will be Mr. Albertson and Mr. Maggio.

I warmly welcome you. Cecil Wooten, who was supposed to be our witness today, is a member of the board of directors and the senior vice president of the administration of CBI Industries and the Chicago Bridge & Iron.

Regrettably, he injured his back, I understand, yesterday while working on his home. Give him my very best wishes. I am sorry he is not here, but Mr. Albertson, we are delighted to have you here, the vice president of Chicago Bridge & Iron, a civil engineer and 30 years with a great company.

In a meeting I had with the chairman and president, Bill Pogue, and executive vice president Cecil Wooten and yourself was a very enjoyable one for me.

I am very impressed with what the company is doing. I think CBI deserves a tremendous amount of credit for putting forward this proposal for steel tank storage, and your company is a great credit to Illinois and its economy.

I wonder if you would proceed, give your testimony, summarizing it in any way you see fit. I have your testimony. I have studied it. I would like for you to read it right into the record.

I am going to ask if, however, you would be good enough to continue while I go over and vote, and I will be right back.

I will be ready to ask you some questions when I get back in.

Mr. ALBERTSON. Certainly.

Mr. MARKS [presiding]. Mr. Albertson?

Mr. ALBERTSON. I am Arthur Albertson, vice president of CBI Industries, Inc. I appear today representing the Chicago Bridge & Iron Co., a wholly owned subsidiary of CBI Industries and on behalf of the Steel Plate Fabricators Association, both headquartered in the Chicago area.

During this statement, I will refer to the Steel Plate Fabricators Association as the association.

Thank you for the opportunity to state the position of our company and the association.

As was stated, we prepared a written statement for inclusion in the record. The association is an organization representing 145 companies that employ approximately 50,000 people. We are vitally interested in the Strategic Petroleum Reserve, both as it affects the security of our country and as a means to reduce unemployment in our industry.

We believe it is the intent of Congress to fill the reserve as quickly as possible. In fact, while the law requires a minimum fill rate of 100,000 barrels per day, Congress has encouraged a fill rate of at least 300,000 barrels per day.

Regrettably, the present storage construction program will not allow this desired fill rate.

These facts have encouraged CBI and the association to study the effect, the use that steel tanks could have on the program's schedule. The results of our study are incorporated in the written statement. The study clearly shows that the storage availability can be accelerated by proceeding immediately with above-ground steel tank terminals.

The U.S. Corps of Engineers agrees with our acceleration analysis and has further indicated that above-ground terminals are cost effective. This is evidenced in their letter included in our written statement.[1]

The DOE report, dated July 1981, entitled "Strategic Petroleum Reserve Acceleration," also concludes that in terms of overall budget costs; "steel tanks are less expensive than a new solution mine site and competitive with Big Hill alternatives because the oil would be acquired sooner." [2]

However, the same report also looks at an investment analysis and concludes that: "Accelerated oil procurement is not a good investment unless a near term supply interruption is foreseen."

The interruption in oil supply that occurred in 1973 was not foreseen in 1972. The SPR was an outgrowth of the 1973 crisis to provide insurance against similar interruptions in the future.

The conclusions of the DOE do not consider the likelihood of a near-term interruption.

In addition to providing a means for accelerating storage availability, on a cost-effective basis, above-ground storage provides important characteristics which complement existing facilities by giving the program additional flexibility:

One, the steel tanks allow segregation of oil by grades providing the Government greater flexibility in their purchasing program and enabling crude withdrawal for specific refineries designed to process that particular crude.

Two, steel tankage permits geographic dispersion of storage and crude segregation where in-ground storage dictates concentration.

Three, the Corps of Engineers letter, incorporated in our written statement, points out the advantage of "100 percent oil recovery in steel tanks versus unknown recovery in solution mine sites."

It further states that: "DOE admits to a 1.5 percent recovery loss, a 5-percent loss is regarded more realistic based upon the many unknowns inherent in long-term storage in solution mine cavities."

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[1] See p. 87.
[2] See p. 97.

This loss factor has not been considered in the DOE storage cost analysis.

Four, the viability of steel tanks is not affected by the number of drawdowns, whereas, in-ground storage in salt domes is limited to a few drawdowns.

Therefore, steel tanks will permit partial use of the reserve, if necessary or desirable, or on a periodic basis without affecting the useful life of the reserve program.

Five, steel tanks can be converted to product storage such as gasoline, fuel oil, jet fuel, and so forth, should the need arise.

The prime advantage of above-ground storage is at least a 2-year acceleration in the current fill schedule for the 750-million-barrel program.

The charts which I am about to show were prepared for an earlier hearing ~~and~~ are based on a DOE award on January 1, 1982, with site selection by April 1, 1982.[1]

The completion dates, therefore, must be extended on a day-for-day basis for the appropriate delay in award. However, the relationship between the time required to complete above-ground versus in-ground storage will remain unchanged.

In a graphical way, I am going to show you by chart what above-ground steel tank terminals can mean to this program.

Chart No. 1, which you see there, shows the 200 million barrels of crude in storage at the end of fiscal year 1981.

By adding to that storage at the fill rate of 300,000 barrels per day, targeted by Congress, the entire 750 million barrels should be in place by the end of fiscal year 1986.

Chart No. 2, based on the present accelerated rated DOE facility development schedule, the 750-million-barrel-fill capacity, using in-ground storage, cannot be attained until the end of fiscal year 1989 which has now been delayed to the end of fiscal year 1990.

Chart 3, here we combine charts 1 and 2, showing a shortfall between the target fill rate set by Congress and the availability of storage as currently planned.

The 750-million-barrel capacity will be in place 3 years late.

Chart No. 4 illustrates that storage and steel tanks can be made available starting in mid fiscal year 1985, with 150 million barrels available by the end of fiscal year 1987.

In the last chart, No. 5, we show here that with the use of steel tanks, the full 750 million barrels of storage can be in place by the end of fiscal year 1987, eliminating the need for the Big Hill development and providing the full storage capability at least 2 years earlier than will be the case if Big Hill goes forward.

The construction of the three 50-million-barrel terminals referred to in these charts will have a major impact on the presently depressed steel and construction industries: 420,000 tons of steel are required, which translates into 1,700 steelworker man-years, and in addition, creates employment for workers in mining, shipping, and other related areas that go hand in hand with steelmaking.

The construction of the terminals translates into 6,150 man-years of work. This industry, which I represent, is suffering from a lack of new construction in this country, resulting from the decline in the rate of expansion of refining and power-generation capacity.

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[1] See p. 71.

The leaching of caverns requires considerable power and water which account for most of the construction costs, but it is not labor intensive.

Steel tankage is labor intensive and will provide more employment.

Since Congress has previously attached urgency to the SPR, we conclude it is desirable to accelerate the construction of these storage facilities. The question of urgency deserves immediate resolution. Our industry is prepared to move expeditiously to assist in the early completion of the SPR.

Thank you.

Mr. **Marks.** Mr. Albertson, Senator Percy will be returning from the Senate floor shortly. He will have some questions for you.

Our next witness is Victor Maggio, who is the international representative for the International Brotherhood of Boilermakers, which has 140,000 members throughout the United States and Canada, including 10,000 in the State of Illinois.

Mr. Maggio's permanent residence is in Calumet City, Ill., south of Chicago.

He holds a graduate degree from Southern Illinois University in Carbondale and while attending college, he joined the Boilermakers Local 374 in Hammond, Ind., and worked on various projects in the Illinois-northeastern Indiana region.

He is formerly director of the finance department for Thornton Township in southern Cook County.

Mr. Maggio, on behalf of Senator Percy, I would like to welcome you here this afternoon.

Proceed with your statement.

Mr. **Maggio.** My name is Victor Maggio. I am an international representative of the construction division of the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers & Helpers, affiliated with the AFL-CIO.

On behalf of Harold J. Buoy, international president of our organization, representing 140,000 members in the United States and Canada, I thank you for this opportunity to address an issue of great concern to this international brotherhood, the Strategic Petroleum Reserve. The International Brotherhood of Boilermakers firmly believes that the Strategic Petroleum Reserve is vital to the security of our Nation.

Our organization supports a strong national defense policy, realizing the direct relation of an adequate oil reserve and our ability to defend our country.

For that reason, we are in concurrence with the original goal of implementing legislation establishing, as quickly as possible, a 750-million-barrel oil reserve, and totally support the priority and urgency recently attached by Congress to the development and fill of the SPR.

It is our understanding that current estimates project between 240 and 270 million barrels of crude oil being in place at the end of this calendar year. This represents approximately one-half of the total amount of the goal provided in the initial legislation.

In testimony by Congressman Marc L. Marks of Pennsylvania, before the House Subcommittee on Fossil and Synthetic Fuels on

March 2, 1982, he explained: "Although adverse market conditions precluded significant fill during the 1979–1980 time frame, this should not have adversely affected the development of capacity."

He further stated: "The administration now recommends that completion of the total capacity of the reserve, to the 750 million barrel level, should be further delayed by one year until the end of fiscal year 1990."

It is only too obvious that the administration not only accepts the current physical constraints of the existing salt domes but further suggests deferring plans to increase capacity, thus reducing the fill rate substantially. It is our opinion that the administration's position is definitely contrary to the intent of Congress to fill the reserve as quickly as possible.

Furthermore, we believe the administration's position fundamentally defeats the purpose of the Strategic Petroleum Reserve, which is to minimize, if not immunize ourselves against the adverse political and economic effects inherent in another crude oil supply interruption.

Our interpretation of these circumstances can only support claims of historical mismanagement, magnified by delay.

This international union cannot impress upon you enough as to the importance and need for immediate plans to develop capacity and fill the reserve. We can no longer tolerate the complacency of the administration and allow further delay of the development and fill of the SPR.

Thus, the International Brotherhood of Boilermakers, Iron Shipbuilders, Blacksmiths, Forgers & Helpers are in favor of substituting above-ground steel tank storage terminals in place of salt-dome-type storage in phase III of the current plan.

Specifically, we support expansion of the SPR to the desired 750-million-barrel capacity via the construction of 140 million barrels of above-ground steel tank storage capacity rather than a similar increase through the development of in-ground type storage proposed at the Big Hill salt-dome located in Texas.

Above-ground steel tank storage can be constructed faster, cost effectively, and be in place for filling in less time than salt-dome-type storage.

Equally important, the inclusion of above-ground steel tank storage terminals would be tremendously labor intensive and contribute to the improvement of the economy.

The following facts will support and substantiate our position:

One, results of a study prepared by the Steel Plate Fabricators Association, which has been submitted to you and included in their testimony, clearly shows that storage availability can be accelerated by proceeding immediately with above-ground steel tank terminals.

Further substantiated: "The only storage mode that can be developed in sufficient volume quickly enough to make an appreciable impact on the 750 million barrel storage timetable is the above-ground steel tank alternative."

Two, in a report conducted by the U.S. Department of Energy, in July 1981, entitled "Strategic Petroleum Reserve Acceleration: Report to the Secretary," analysis of costs between the construction of above-ground steel tanks proved to be less expensive than development of a new solution-mined site and in terms of overall budget costs, competitive to the Big Hill alternative, basically due to the timely acquisition of oil in both instances.

The U.S. Corps of Engineers' analysis, dated October 19, 1981, supports DOE's findings and takes the position that comparatively above-ground storage terminals are cost effective.

Three, substitution of 140 million barrels of above-ground steel tank storage for an equal amount of in-ground storage would allow for a 3- to 4-year acceleration of the SPR and accomplish establishment of the total reserve.

By creating additional storage capacity in less time than anticipated, the United States could take advantage of the existing oil glut, reduce overall costs, and place the entire reserve intact.

For the inclusion of above-ground steel tanks and in relation to salt-dome storage, which I will avoid reiterating at that time and submit it for the record, but I would like to——

Senator PERCY. It will be incorporated in the record.

Mr. MAGGIO. But one particular point, and most importantly a major concern of ours: utilization of above-ground steel tank storage represents a far greater job creating potential than in-ground salt dome storage.

Manpower projections relative to the inclusion of above-ground steel tank storage terminals to the current plan are astronomical in terms of man-years of employment.

As previously stated, the incorporation of steel tanks would require the production of more than 400,000 tons of steel and provide the currently depressed steel industry with over 1,700 man-years of employment as well as it would create additional employment for people involved in the mining of raw materials associated to steel production.

Furthermore, as it specifically applies to the construction industry, steel tanks represent almost 6,500 man-years of work in the fabrication and construction of the terminals.

In an industry currently plagued with a nationwide unemployment rate between 20 and 25 percent, the advantages surrounding the construction of steel tanks with regard to the economy are endless.

We ask, and without explanation, that you consider the ripple effect and the direct impact on the domestic economy and ask that you consider the effects of this principle which is most applicable in this situation.

On behalf of the international union and 130,000 American members, I urge your support of this proposal and ask that you seriously consider inclusion of above-ground steel tank storage terminals as part of the strategic petroleum reserve.

Senator PERCY. Mr. Maggio, I have not met all of your 130,000 members, but you know I have met with a great many boilermakers through the years; we have had very, very good sessions. I have found them to be an informed and an interested group, not self-serving. They are interested in the national interest. And, yes, self-interest is a part of it, also.

I have just finished a meeting.

Without any question on the minds of everyone there, with 10.4 percent unemployment rate in Illinois, is how do we create the right climate to create jobs. When you have a Strategic Petroleum Reserve, and I felt you had a glut and you had a softening of prices, that was the time to fill it; the time to build and do the kinds of things for the future is when you have got people available, and the unemployment levels are just astounding in your industry.

Let's just have one question about this: We have been talking about how a more dispersed Strategic Petroleum Reserve might have security advantages, making it worth a few more dollars a barrel, if, in fact, it does cost anything extra to disperse the Strategic Petroleum Reserve it might also be worth a small price, if it means we can provide thousands of jobs for those in the construction trade, steel industry and members of the Oil and Chemical Workers Union.

This is no light work project of any kind. This is an essential need that we require. It is a way of ultimately enhancing security by helping the Treasury by putting American workers back on tax rolls and off the unemployment rolls.

The vote we just had—and we will work out a bill of compromise to provide the funding for it—was to extend, to 1 full year, unemployment compensation. There are people that just simply are unable to get jobs.

If you try to find a job in the housing industry today, you just cannot do it.

How would this program, if we got it underway, affect your members in Illinois, where you have some 10,000 members, I believe.

Mr. MAGGIO. That is correct, Senator.

Senator PERCY. From a timing standpoint, is this the time to go ahead and do it?

Mr. MAGGIO. It is my understanding that under certain conditions that I believe are noted in the testimony of the Steel Plate Fabricators Association relative to site and particular specifics, and, in fact, the American Iron & Steel Institute, in testimony before a House Subcommittee on Fossil and Synthetic Fuels, on March 2 stated that: "Production of much of the metals and steel, necessary, would take place in Illinois, Indiana, Texas, Alabama, California, and five other States."

Certainly, with 10,000 members residing in Illinois, a number of those people, we would think, if the production of steel would be in the State of Illinois, would certainly be affected in the fabrication of the materials to construct the terminals.

Certainly, by bid process, would be the end result and the determining factor as to how it would directly affect those in Illinois.

But, certainly, they are available and ready to stand by to participate in this.

Senator PERCY. Good. It seems to me as a former businessman, that if you are going to do something, and you pick a time of full employment to do it, the total cost of all the labor and everything else is high, and you don't get the advantage, in the competitive, intense bidding that you would be doing on the projects.

If you are doing it at a time of high unemployment where you are paying so much in unemployment compensation anyway, the cost is a fraction of the cost when people are unemployed, and if you put them to work, you get them off unemployment compensation, which is paid for anyway, one way or the other.

It just seems that, of all the times to do it, this is the time to do it.

Mr. Albertson, we have been talking mainly today a lot on unemployment and employment, but national security. I have been concerned that recent trends in energy and defense policies may end up costing us jobs in Frost Belt States like Illinois, while creating jobs in Sun Belt States like Louisiana.

I want to say that with respect in any decentralized energy technology that keeps the money, the jobs and the people in their own hometown community. I see this is another advantage of having dispersed a Strategic Petroleum Reserve.

What are your thoughts on that? How many jobs do you think this would create in places like Illinois?

Mr. **Albertson.** One quick answer to what Mr. Maggio just said here: If you had a Government site available in Illinois, and if the Government wanted to and would get us the necessary permits, we would begin field construction in 6 months after we had an order to proceed. We would have the first oil tank ready to receive crude in 12 to 14 months on that basis.

The schedule we have given here says the first five tanks would be completed in fiscal year 1985, but that is on the normal schedule.

On the matter of security, we feel a diversified SPR is one that contains different type products, in other words, when you build aboveground steel storage tanks, you are not just limited to one product. You are going to be able to put a lot of different products in these tanks, if you desire to.

The bottom line on all this is, are we safer than the salt domes? That seems to be the comparison that is being made regularly. Let me say that should someone attempt to sabotage the salt dome storage, then I assume the easiest thing would be to dismantle the power system which has no security connected with it at all.

Salt domes require a large power supply for the pumping purposes. Above-ground tanks could also have the power supply dismantled, but pure gravity would still allow the use of a large portion of the crude oil.

Also, I wish to say that the individual tanks above ground are all diked individually which adds, certainly, an amount of security. In other words, it is above my imagination to think that you are going to destroy every tank should someone sabotage an above-ground terminal. You may get one tank. That happens even in refineries.

Now, the pipeline serving the salt domes or above-ground terminals could be dismantled. This could happen at the same time you don't have any electrical power. Again, in above-ground steel tanks, if you have got trucks or if you have got railroads, we can still empty the tanks and get it where it has to go.

I know you are in a hurry, Senator.

Senator **Percy.** Very much, indeed.

We must adjourn at 1 o'clock. We are right there.

I wish in the transcript we could write up and put all our pictures in. That is the most attractive testimony I have seen in 15 years, and it is good testimony.

We appreciate both of you very much indeed being here as well as our other witnesses.

Thank you.

[The prepared statements of Mr. Handy and Mr. Stevenson, a statement by Cecil A. Wooten, representing the Chicago Bridge & Iron Co., with attachments, submitted by Mr. Albertson, and the prepared statement of Mr. Maggio, follow:]

TESTIMONY OF MR. DONALD G. HANDY
PRESIDENT, ILLINOIS ALCOHOL FUEL ASSOCIATION

BEFORE THE U.S. SENATE SUBCOMMITTEE ON
ENERGY, NUCLEAR PROLIFERATION, AND GOVERNMENT PROCESSES.

THE COMMITTEE ON GOVERNMENTAL AFFAIRS

MAY 21, 1982

Mr. Chairman, on behalf of the membership of the Illinois Alcohol Fuel Association, I would like to thank you for this opportunity to appear before your Committee. The fact that the state of Illinois can claim the lion's share of the Nation's alcohol fuel production capacity is due in large measure to the leadership you have provided in the Congress, and to your foresighted commitment to encouraging domestic alternative energy development.

We are particularly happy to be here today to express our support for the legislation just recently introduced by yourself and Illinois' junior senator, the Honorable Alan J. Dixon. This important measure, which has also been introduced by a number of House members, including Congressman Paul Findley, deserves immediate enactment and implementation.

While no panacea, this legislation offers the Secretary of Agriculture an important means of increasing outlets for surplus agricultural commodities. By providing the Secretary with broad discretionary authority to accept bids from alcohol fuel producers of any size to process surplus commodities into fuel alcohol, the legislation enables the Department of Agriculture to take advantage of those situations where taxpayer costs for storage, transportation, and handling can be reduced. This legislation is also important because it would direct the Secretary to retain title to the alcohol produced pursuant to these processing contracts, and to sell the alcohol fuel to the Federal government — either the General Services Administration (GSA) or the Defense Fuel Supply Center (DFSC) — for use in the Federal fleet as required under 42 USC and Executive Order 12261. Such a requirement could not only result in reductions in Federal government fuel costs, but it also insures that the fuel alcohol sales would not distort the fledgling private sector market, which remains "soft" due to the current gasoline oversupply situation.

As you know, Mr. Chairman, there are those who would oppose this legislation, claiming that such a program would be unworkable, or require excessive taxpayer expense. All of the detractors' objections can be answered satisfactorily, however, especially the latter one. I am sure you would agree that most of these objections sound much like the earlier objections that were raised to the establishment of an alcohol fuels industry itself. You will recall the most common ones, I'm sure, since you played such a major role in rebutting them. Alcohol fuels production on a commercial scale could never happen, the "experts" said, because: (A) the technology would always require far more energy to produce a gallon of alcohol than it yielded; (B) alcohol in gasoline would ruin engines and severely diminsh performance and mileage; (C) an alcohol fuels industry would cause food prices to skyrocket; (D) other liquid fuel alternatives like shale oil and tar sands made far more economic sense, and would be commercial long before any significant alcohol fuels industry could develop; and soon.

Today, I emphasize that all of these charges have been disproven. While giant oil shale and tar sands projects, despite the benefit of massive governmental supports, are being terminated, the U.S. alcohol fuels industry is steadily expanding. By the middle of next year nearly 400 million gallons of annual production capacity -- 10 million barrels -- will be on-line. Even in the face of significant reductions in gasoline consumption, fuel alcohol use grew by 25% last year. Ethanol-enhanced blends are being marketed nation-wide as high-performance products, and favored by motorists as clean burning, high octane fuels. New alcohol fuel facilities — from small-scale, on-farm operations to 60 million gallon per year plants — provide clear net energy gains, and technology breakthroughs occur every day. And even while research progresses on the conversion of abundant, non-grain cellulosic feedstocks to alcohol fuel, first-generation facilities have proven beyond a doubt that the utilization of corn and other grains in the alcohol production process does not present us with a "food vs. fuel" dilemma, but instead allows the "value-added" processing of such grains into valuable food- and feed co-products and a liquid fuel. Jobs are created, tax bases are expanded, and a more concentrated product is available for domestic and foreign use.

Mr. Chairman, your legislation is important to the American agricultural community because it increases flexibility. A badly needed new outlet is provided which can assist the Secretary in his efforts to break the vicious cycle of low profitability, overproduction, and costly federal government takeover of surplus stocks. By starting with a gradual, manageable program, your legislation will provide the basis for a proven complement to the conventional approach to bulk grain trade and utilization. The Department of Agriculture has recently released studies which underscored the need for more value-added processing of American agricultural commodities. For instance, it has been estimated that, if only 10 percent of the $8.7 billion worth of corn exported by the U.S. last year were "processed" into wet corn milling products for export, business activity would increase by $7.734 billion, 165,300 more jobs would be created, and personal income in the U.S. would rise by $1.713 billion.

In the time remaining, I would briefly like to respond to several of the most commonly heard objections to your legislation.

I. "The legislation is not needed, since the USDA has recently announced a pilot project to use 4 million bushels of distressed grains for processing into fuel alcohol."

It is true that Secretary Block recently announced his intent to conduct a pilot program to utilize 4 million bushels of off-grade CCC corn for conversion into fuel alcohol, but this only legitimizes further the concept of your legislation, and certainly does not eliminate its need.

Your legislation, while providing the Secretary with full discretion to make awards as he sees fit, improves on the pilot program in at least three ways.

(1) It would not limit the Secretary's "geographic scope" in the acceptance of processing bids. There are thousands of CCC elevators across the country, and dozens of fuel alcohol facilities. The enactment of this legislation would make them all eligible to compete, which could save significant amounts of taxpayer dollars.

(2) It would not limit the Secretary to taking bids for only distressed or sample grades of surplus corn. While clear budgetary savings would result from use of deteriorated grain, there are many possible situations where the CCC could come out ahead by contracting for processing of even #2 and #3 corn.

(3) It would avoid the difficulties that would result from selling fuel alcohol produced under this program into the private market, where it would unfairly compete with private producers. By taking advantage of the savings that would result from reduction of grain storage, handling,

interest, and transportation costs, the fuel alcohol could likely be sold at a price that would provide further Federal government savings from lowered fuel costs.

II. "The legislation would be too costly."

This contention is most easily disproven by reading the bill language. Nowhere is the Secretary required to make awards for surplus grain processing. Obviously, he would only do so if competing facilities were able to offer a contract that would, all things considered, reduce the CCC's cost for storing, handling, and transporting surplus grain.

While the precise costs seem to be not generally understood, it is clear that the American taxpayer puts up to $.80- per bushel per year into CCC corn. It is not hard to see that significant savings would result if, instead of holding a bushel of corn for 3 or 4 years, its acquisition cost could be immediately recovered by the sale of fuel alcohol (assuming 2.5 gallons per bushel, and a sales price of only $1.00 per gallon). Even after paying for processing, handling, storage, and transportation of the alcohol, in many cases the savings could be large. And if there were further disruptions in our export markets, for instance, further unrest in Poland, even greater savings would accrue.

III. "The program's impact would be so small it is not worth the effort."

This statement is also very inaccurate. While it is true that the fact that the Federal fleet consumes only 500 million gallons of gasoline annually and at a 10 percent blend ratio this would require

50 million gallons of ethanol, the 20 million bushels of corn that would be utilized at this level would amount to almost 10 percent of current CCC corn stocks. Grain traders would testify to the fact that this is a significant level, and the psychological effect especially would be positive.

If conditions warranted, however, even larger amounts of grain could be used. For instance, again as a result of your efforts, the U.S. Postal Service is now running an extensive fleet test of vehicles on pure alcohol in both Springfield, Illinois and Denver, Colorado. Results to date have been extremely positive, and there is no reason why captive fleet vehicles all over the country could not be modified to run on pure alcohol, thus greatly expanding the market.

Or, this program could be used as a bridge to realize another one of your proposals, the creation of a Strategic Alcohol Fuel Reserve (SAFURE). By devoting a very small percentage of the funds now appropriated for the Strategic Petroleum Reserve (SPRO), surplus fuel alcohol produced from CCC stocks could be stored in dispersed locations throughout the country. Unlike the crude oil in the SPRO - much of which is purchased from foreign oil producers - fuel alcohol in the SAFURE will be widely dispersed, available for immediate access by farms and rural communities, would not require further refining, and could be easily tapped. The private industry has proven that fuel alcohol can be stored efficiently, safely, and economically.

Obviously, then, if a national emergency were to require it, the Nation's alcohol fuel industry, if one assumed that it operated at approximately a 70% rate, could produce over 130 million gallons of alcohol next year (30% of 400 million), thus utilizing over 50 million bushels of surplus corn, which would amount to nearly 20 percent of the current CCC surplus. Not an insignificant contribution by any standard.

CONCLUSION.

In conclusion, Mr. Chairman, on behalf of the Illinois Alcohol Fuels Association, I would like to once again thank you and the rest of the members of your Subcommittee and staff for this opportunity to present our views in support of this legislation, as well as for your leadership and support for the development of the vital alternative energy industry in this country.

We believe that any doubts regarding this legislation will be put to rest upon implementation. We know the nation will quickly benefit from the legislation.

Thank you very much.

NATIONAL
CORN GROWERS
ASSOCIATION

Suite 645
818 18th Street, N.W.
Washington, D.C. 20006
Telephone: (202) 223-6296

THE NATIONAL CORN GROWER ASSOCIATION POSITION ON THE UTILIZATION OF COMMODITY CREDIT CORPORATION SURPLUS GRAINS FOR THE PRODUCTION OF FUEL ALCOHOL

BY

JOHN STEVENSON, VICE PRESIDENT, LEGISLATIVE AFFAIRS

NATIONAL CORN GROWERS ASSOCIATION

BEFORE

THE SENATE SUBCOMMITTEE ON ENERGY

UNITED STATES SENATE

ON

MAY 21, 1982

MR. CHAIRMAN AND DISTINGUISHED COMMITTEE MEMBERS: THANK YOU FOR THE OPPORTUNITY TO PRESENT THE VIEWS OF THE NATIONAL CORN GROWER ASSOCIATION.

I AM JOHN STEVENSON, LEGISLATIVE VICE PRESIDENT OF THE NCGA AND A CORN FARMER NEAR CIRCLEVILLE IN SOUTH CENTRAL OHIO. WE FARM IN EXCESS OF 3,000 CROP ACRES AND ALSO OPERATE AN ON FARM ETHANOL PLANT OF 200,000 GALLON ANNUAL CAPACITY.

SOON AFTER THE GRAIN TRADE SANCTIONS OF 1980 THE NATIONAL CORN GROWER DIRECTORS FORMED THE POLICY OF ENCOURAGING THE USE OF CORN FOR THE PRODUCTION OF ALCOHOL FUELS. WHEN THE COARSE GRAIN PURCHASED BY THE CCC BECAME AN APPARENT PROBLEM

TO THE MARKET, THE NCGA FORMED ADDITIONAL POLICY WHICH STATED THAT WE FAVORED THE CONVERSION OF THAT COARSE GRAIN INTO FUEL ALCOHOL TO BE PLACED INTO A DEFENSE RESERVE.

SO THE NATIONAL CORN GROWER ASSOCIATION'S POLICY AND IDEAS ARE CERTAINLY IN CONCERT WITH THE THINKING OF THOSE FAVORING THIS PROPOSED LEGISLATION.

FARMERS ARE MANY TIMES TERMED TO BE HABITUAL COMPLAINERS AND PROBABLY RIGHTFULLY SO AS WE FIND OURSELVES AT THE MERCY OF THE WEATHER AND ON OCCASION RATHER DEVASTATED BY AN IMMEDIATE CHANGE IN FOREIGN OR DOMESTIC POLICY.

AGAIN, I MENTION THE EMBARGO OF 1980 BECAUSE IT EMPHASIZED THIS NATION'S ONE GREAT STRENGTH, ITS AGRICULTURE AND CERTAINLY NOT THE OVERFLIGHT OF AFGANISTAN BY 20 YEAR OLD B-52S.

BUT FARMERS WERE DEEPLY CONCERNED BECAUSE THEY KNEW THEY COULD NOT SACRIFICE MUCH IN THEIR BUYING POWER OR THE REST OF THE ECONOMY WOULD BE HURT AS WELL BECAUSE IT IS FACT WE PROVIDE DIRECTLY AND INDIRECTLY 27-29% OF THE JOBS IN THE NATION'S LABOR FORCE.

THEN TO COMPOUND THE PROBLEM WE WERE BLESSED IN 1981 WITH THE GREATEST CROP EVER. WE ARE THE ENVY OF THE WORLD!

BUT THE PROBLEM WE ARE ADDRESSING TODAY IS PARTIALLY THE RESULT OF THE 1980 EMBARGO AND THE LOST MARKETS OF THAT YEAR AND SUBSEQUENT YEARS SINCE 100,000,000 OF THE 262,000,000 IN CCC ACCUMULATED THEN.

WE LIKE SECRETARY BLOCK'S PILOT PROGRAM OF UTILIZING THE 30,000,000 BUSHELS OF OUT OF CONDITION CCC CORN FOR CONVERSION INTO ETHANOL. THIS PROGRAM WILL BE AN ENHANCER TO PARTICULARLY THE DRY MILLER OR SMALLER VOLUME ALCOHOL PRODUCERS WHO RALLIED IN GOOD FAITH BUT ARE IN A DESPARATE STRUGGLE TODAY.

I HAVE INFORMALLY CHATTED WITH SECRETARY BLOCK ABOUT THE DISCONTINUANCE OF GUARRANTEES AND GRANTS AND I RESPECT THE ADMINISTRATION'S PHILOSOPHY THAT IF THE ETHANOL INDUSTRY SUCCEEDS IT WILL BE BY THE PRIVATE SECTOR. BUT IT IS HARD TO COMPETE WITH AN ENERGY INDUSTRY THAT HAS BEEN HEAVILY SUBSIDIZED OVER THE YEARS, PARTICULARLY WHEN YOUR INDUSTRY'S MAJOR SUBSIDATION IS TAX CREDITS YOU CAN NOT USE.

AS CORN PRODUCERS LOOK TOWARD HARVEST THEY ARE CONCRNED ABOUT THE ACCUMULATION OF CCC GRAINS TO 315,000,000 BUSHELS AS PREDICTED BY USDA. SOME PRODUCERS ARE RELUCTANT TO ENTER THE REDUCED ACREAGE PROGRAM BECAUSE THEY FEEL IF THEIR PRODUCTION GOES INTO THE RESERVE OR CCC THROUGH FORFEITURE THEN THE MARKET IS CAPPED BY THOSE TRIGGER PRICES AND FOR MANY PRODUCERS THOSE TRIGGERS DO NOT MEET THE COST OF PRODUCTION. THENCE, THEY REASON WE SHOULD TAKE THE BEATING NOW RATHER THAN HAVING A BURDEN OVER OUR HEADS FOR YEARS TO COME.

FARMERS ARE AWARE THAT FOR EACH 100,000,000 BUSHELS PERMANENTLY REMOVED FROM THE MARKET WE CAN EXPECT A 12¢ INCREASE IN PRICE PER BUSHEL. HOWEVER, IF COPRODUCTS RETURN TO COMPETE THEN THIS 12¢ CAN BE REDUCED BY 4-6¢.

THEREFORE, I SUGGEST A DEFENSE RESERVE OF DISTILLERS DRIED GRAINS, A PORTION TO BE OF NUTRITIVE VALUE SO THAT THE ALREADY TENSE MARKETS COMPOSED OF SOY BEAN MEAL AND CORN GLUTEN MEAL WILL NOT BE CAST INTO FURTHER JEOPARDY.

CORN GLUTEN MEAL JUST ESCAPED DUTIES LEVIED BY THE EUROPEAN COMMUNITY ONLY BECAUSE OF THE FIRMNESS OF SECRETARY BLOCK.

CONSEQUENTLY, PRODUCERS VIEW THIS PROGRAM FAVORABLY IF THERE ARE ASSURANCES THAT COPRODUCTS WILL NOT CAUSE AN IMBALANCE TO OTHER COMMODITIES OR BECOME A BURDEN TO THE FEED GRAINS.

GENTLEMEN, IN CLOSING IF I MAY SHARE AN OBSERVASION THAT DURING THE PAST DECADE DETENTE WITH EASTERN EUROPE SEEMS TO CYCLE WITH DIET. THE MORE SPARSE THEIR DIET THE MORE AGGRESSIVE THEY BECOME.

CONCENTRATED DISTILLERS GRAINS AS A HUMAN SUPPLEMENT AS WELL AS ANIMAL FEED MIGHT BE THE BEST OFFENSE/DEFENSE STRATEGY WE COULD FOLLOW IF PRESENTED AS A PL 480 PROGRAM.

IT IS IMPERATIVE WE KEEP EASTERN EUROPE DEPENDENT UPON OUR FOOD PRODUCTION BECAUSE THAT IS THE ONLY BARGAINING POWER WE HAVE AT THIS TIME.

AGAIN, WE THANK YOU FOR THIS OPPORTUNITY TO PRESENT OUR VIEWS AND COMMEND EACH OF YOU FOR STUDYING THIS WORTHY SOLUTION TO A MOUNTING PROBLEM.

AND, MR. CHAIRMAN, THE ALCOHOL FUEL INDUSTRY SALUTES YOU FOR YOUR CONSISTENT AND STEADFAST SUPPORT OVER THE PAST SEVERAL YEARS.

THANK YOU.

STATEMENT OF CECIL A. WOOTEN

Representing
Chicago Bridge & Iron Company
and the
Steel Plate Fabricators Association
Before the Subcommittee on
Energy, Nuclear Proliferation and Government Processes

ACCELERATING THE STRATEGIC PETROLEUM RESERVE ("SPR")

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B. CHARTS ILLUSTRATING THE EFFECT THREE 50 MILLION BARREL ("MMB") STEEL TANK TERMINALS COULD HAVE ON ACCELERATING THE SPR PROGRAM.

C. COST ESTIMATE FOR A 50MMB STEEL TANK STORAGE FACILITY IN JANUARY 1982 DOLLARS.

D. DESCRIPTION OF 50MMB STEEL TANK STORAGE FACILITY.

E. BAR CHART SCHEDULE FOR CONSTRUCTION OF A TYPICAL 50MMB STEEL TANK STORAGE FACILITY.

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SECTION 2 - CONSIDERATIONS FOR ABOVE GROUND STEEL STORAGE TANKS.

SECTION 3 - RESPONSE OF THE U.S. CORPS OF ENGINEERS TO A CONGRESSIONAL INQUIRY CONFIRMING THE COST EFFECTIVENESS OF STEEL TANKAGE.

SECTION 4 - "STRATEGIC PETROLEUM RESERVE ACCELERATION REPORT TO THE SECRETARY" BY THE STRATEGIC PETROLEUM RESERVE OFFICE OF THE DEPARTMENT OF ENERGY, DATED JULY, 1981.

I am Cecil Wooten, Senior Vice President of Chicago Bridge & Iron Company and Treasurer of the Steel Plate Fabricators Association, both headquartered in the Chicago area. During this statement, I will refer to the Steel Plate Fabricators Association as the Association.

Thank you for the opportunity to state the position of our company and the Association. We have prepared a written statement for inclusion in the record.

The Association is an organization representing 145 companies that employ approximately 50,000 people. We are vitally interested in the Strategic Petroleum Reserve both as it affects the security of our country, and as a means to reduce unemployment in our industry.

We believe it is the intent of Congress to fill the Reserve as quickly as possible. In fact, while the law requires a minimum fill rate of 100,000 barrels per day, Congress has encouraged a fill rate of at least 300,000 barrels per day. Regretably, the

These facts have encouraged CBI and the Assocation to study the effect the use of steel tanks could have on the program's schedule. The results of our study are incorporated in the written statement. The study clearly shows that storage availability can be accelerated by proceeding immediately with above ground steel tank terminals.

The U.S. Corps of Engineers agrees with our acceleration analysis and has further indicated that above ground terminals are cost effective. This is evidenced in their letter included in our written statement.

The DOE Report, dated July, 1981, entitled "Strategic Petroleum Reserve Acceleration", also concludes that in terms of overall budget costs, "steel tanks are less expensive than a new solution-mined site and competitive with Big Hill alternatives because the oil would be acquired sooner" (see page III-3, Section 4 of our written statement). However, the same report also looks at an investment analysis and concludes that accelerated oil procurement is not a good investment unless a near term supply interruption is foreseen.

The interruption in oil supply that occurred in 1973 was not foreseen in 1972. The SPR was an outgrowth of the 1973 crisis to provide insurance against similar interruptions in the future. The conclusions of the DOE do not consider the likelihood of a near term interruption.

In addition to providing a means for accelerating storage availability, on a cost effective basis, above ground storage provides important characteristics which complement existing facilities by giving the program additional flexibility:

1. Steel tanks allow segregation of oil by grades providing the government greater flexibility in their purchasing program and enabling crude withdrawal for specific refineries designed to process that particular crude.

2. Steel tankage permits geographic dispersion of storage and crude segregation where inground storage dictates concentration.

3. The Corps of Engineers' letter, incorporated in our written statement, points out the advantage of "one hundred percent oil recovery in steel tanks versus unknown recovery in solution-mined sites". It further states that "DOE admits to a 1.5% recovery loss. A 5% loss is regarded as more realistic based upon the many unknowns inherent in long-term storage in solution-mined cavities". This loss factor has not been considered in the DOE storage cost analysis.

4. The viability of steel tanks is not affected by the number of drawdowns whereas inground storage in salt domes is limited to a few drawdowns. Therefore, steel tanks will permit partial use of the reserve, if necessary or desirable, on a periodic basis without affecting the useful life of the reserve program.

5. Steel tanks can be converted to product storage such as gasoline, fuel oil, jet fuel, etc. should the need arise.

The prime advantage of above ground storage is a two year acceleration in the current fill schedule for the 750 million barrel program.

The charts which I am about to show were prepared for an earlier hearing and are based on a DOE award of January 1, 1982 with site selection by April 1, 1982. The completion dates, therefore, must be extended on a day for day basis for the appropriate delay in award. However, the relationship between the time required to complete above ground versus in ground storage will remain unchanged.

CHART 1 - shows 200 million barrels of crude in storage at the end of FY 1981. By adding to that storage at the fill rate of 300 thousand barrels per day targeted by Congress, the entire 750 million barrels should be in place by the end of FY 1986.

CHART 2 - based on the present "accelerated" DOE Facility development schedule, the 750 million barrel fill capacity, using inground storage, cannot be attained until the end of FY 1989.

CHART 3 - combines Charts 1 and 2, showing a short fall between the target fill rate set by Congress and the availability of storage as currently planned. The 750 millon barrel storage capacity will be in place 3 years late.

CHART 4 - illustrates that storage in steel tanks can be made available, starting mid FY 1985, with 150 million barrels available by the end of FY 1987.

CHART 5 - shows that with the use of steel tanks, the full 750 million barrels of storage can be in place by the end of FY 1987, eliminating the need for the Big Hill Development and providing the full storage capability two years earlier than will be the case if Big Hill goes forward.

The construction [illegible] e three 50 million barrel terminals referred to in these charts will have a major impact on the presently depressed steel and construction industries. 420,000 tons of steel are required which translates into 1,700 steelworker man years, and in addition, creates employment for workers in mining, shipping and other related areas that go hand in hand with steel making.

The construction of the terminals translates into 6,150 man years of work. This industry, which I represent, is suffering from a lack of new construction in this country, resulting from the decline in the rate of expansion of refining and power generation capacity.

The leaching of caverns requires considerable power and water which account for most of the construction cost, but is not labor intensive. Steel tankage is labor intensive and will provide more employment.

Since Congress has previously attached urgency to the SPR, we conclude it is desirable to accelerate the construction of storage facilities. The question of urgency deserves immediate resolution. Our industry is prepared to move expeditiously, to assist in the early completion of the SPR.

Thank you.

APPENDIX - B

THE FOLLOWING FIVE CHARTS ILLUSTRATE THE EFFECT 3 - 50MMB STEEL TANK STORAGE FACILITIES COULD HAVE ON THE CURRENT SPR DEVELOPMENT PROGRAM.

CHART 1 - SHOWS 200MMB OF CRUDE IN STORAGE AT THE END OF FY 1981. BY ADDING TO THAT STORAGE AT THE FILL RATE TARGETED BY CONGRESS, THE ENTIRE 750MMB SHOULD BE IN PLACE BY THE END OF FY 1986.

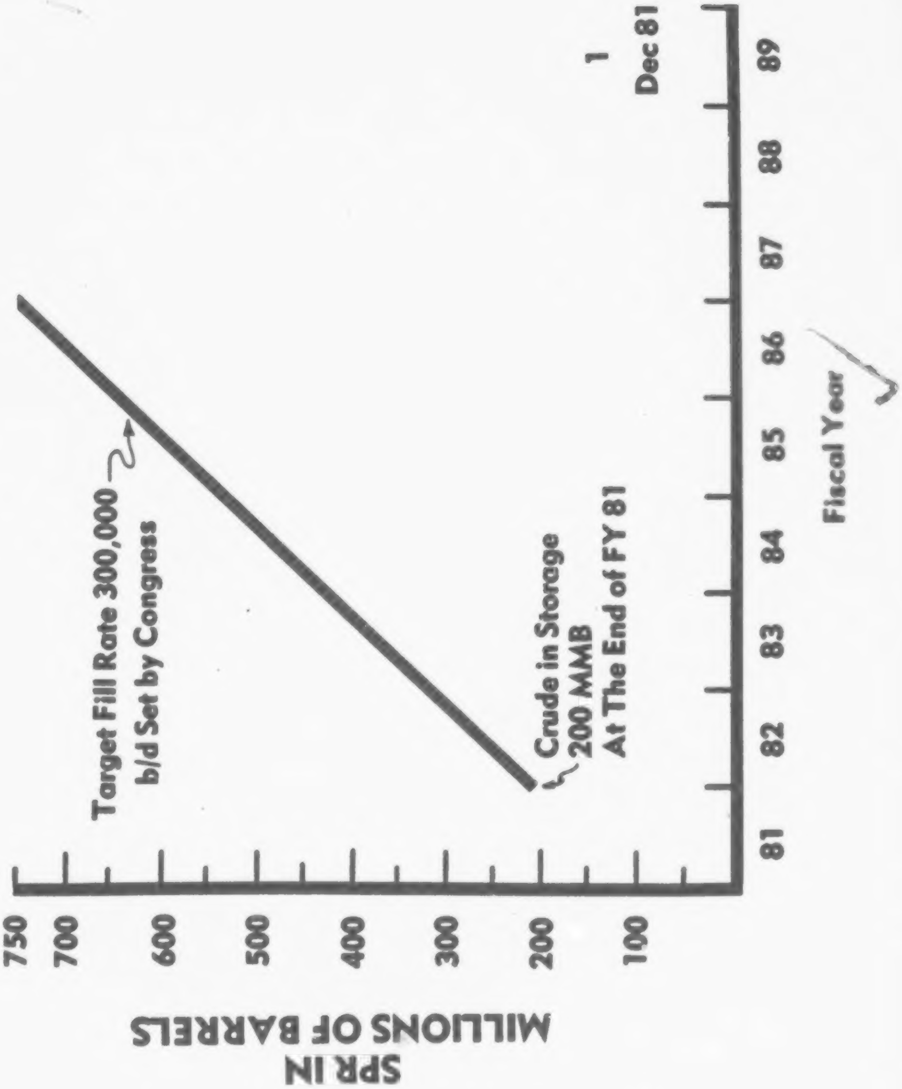
CHART 2 - BASED ON THE 'ACCELERATED' DOE FACILITY DEVELOPMENT SCHEDULE SHOWN IN TABLE IV.1, PAGE IV-3 OF DOE'S JULY, 1981 REPORT, THE 750MMB FILL CAPACITY CANNOT BE ATTAINED UNTIL THE END OF FY 1989.

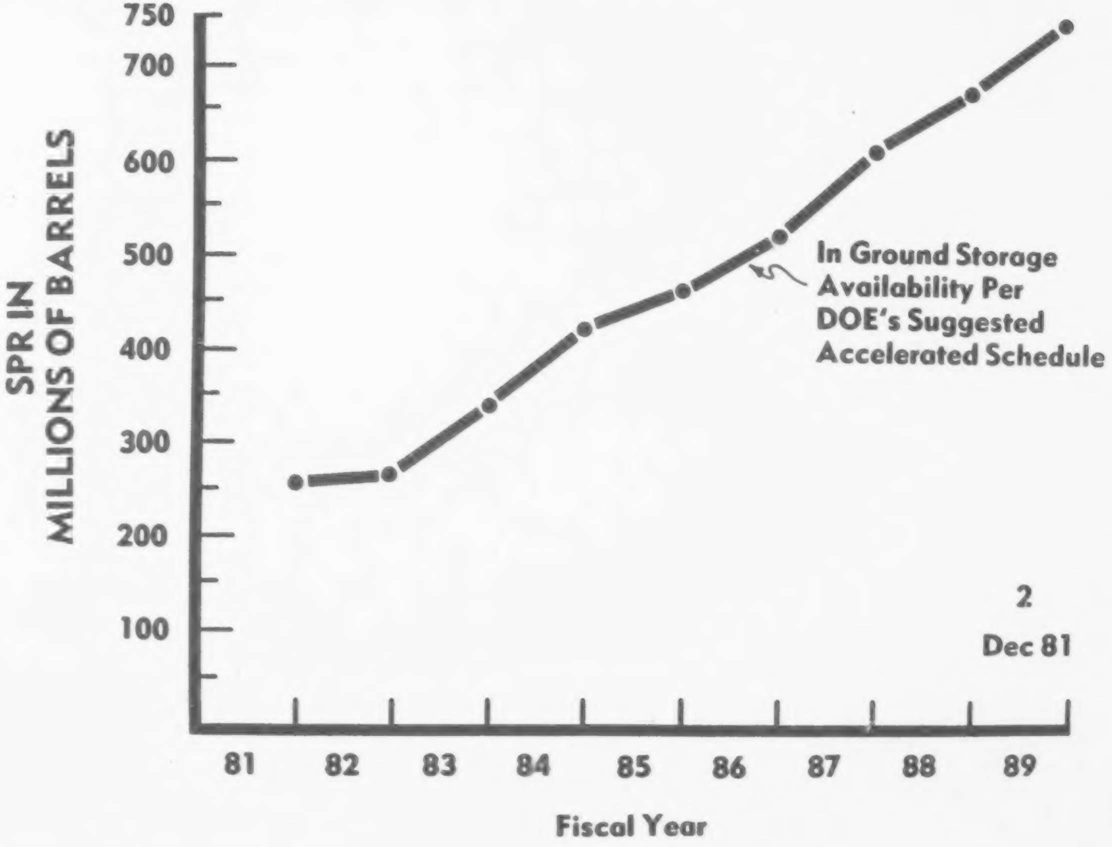
CHART 3 - COMBINES THE INFORMATION ON CHARTS 1 AND 2, SHOWING A SHORT FALL BETWEEN THE TARGET FILL RATE SET BY CONGRESS AND THE AVAILABILITY OF STORAGE AS CURRENTLY PLANNED. THE 750MMB STORAGE CAPACITY WILL BE IN PLACE 3 YEARS LATE.

CHART 4 - ILLUSTRATES THAT STORAGE IN STEEL TANKS COULD BE MADE AVAILABLE, STARTING MID FY 1985 WITH 150MMB AVAILABLE BY END FY 1987.

CHART 5 - SHOWS THAT WITH THE USE OF STEEL TANKS, THE FULL 750MMB OF STORAGE CAN BE IN PLACE BY END OF FY 1987, ELIMINATING THE NEED FOR THE BIG HILL DEVELOPMENT AND PROVIDING THE FULL STORAGE CAPABILITY 2 YEARS EARLIER THAN WILL BE THE CASE IF BIG HILL GOES FORWARD.

NOTE: These charts assume contract award by 1/1/82 with site selection by 4/1/82. A delay in award would delay completion on a day for day basis. However, the relationship between time required to complete above ground storage and in ground storage would remain unchanged.


SPR IN MILLIONS OF BARRELS
750
700
600
500
400
300
200
100
Fiscal Year
81
82
83
84
85
86
87
88
89
Dec 81
Target Fill Rate 300,000 b/d Set by Congress
Crude in Storage 200 MMB At The End of FY 81


SPR IN
MILLIONS OF BARRELS
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700
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500
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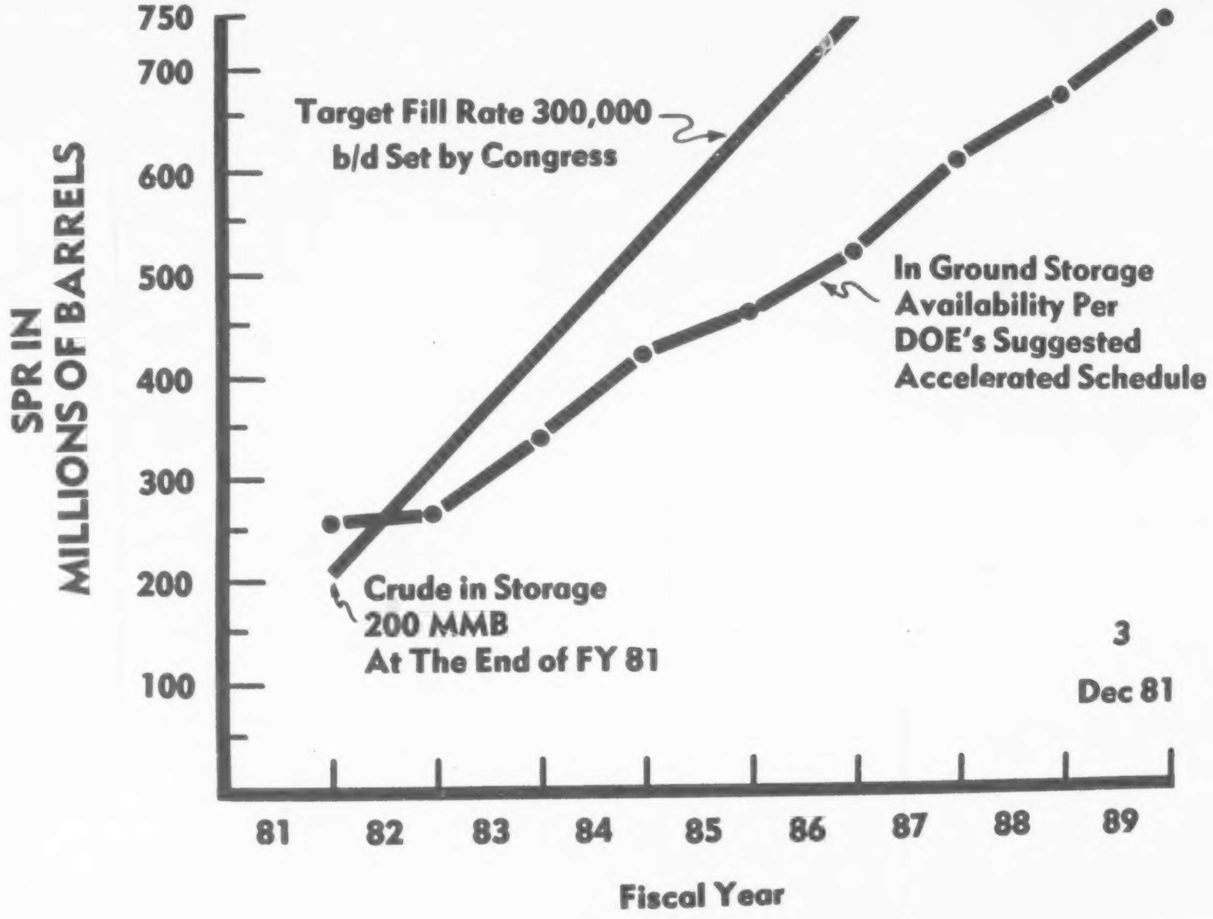
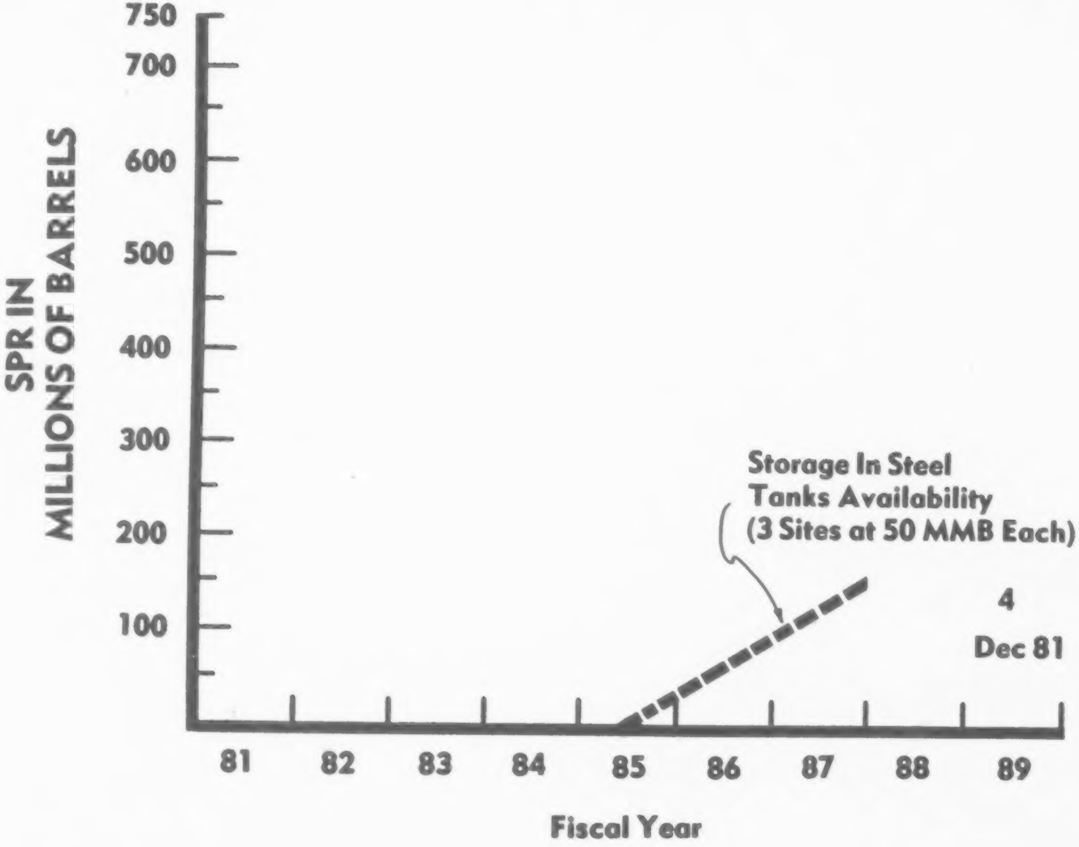
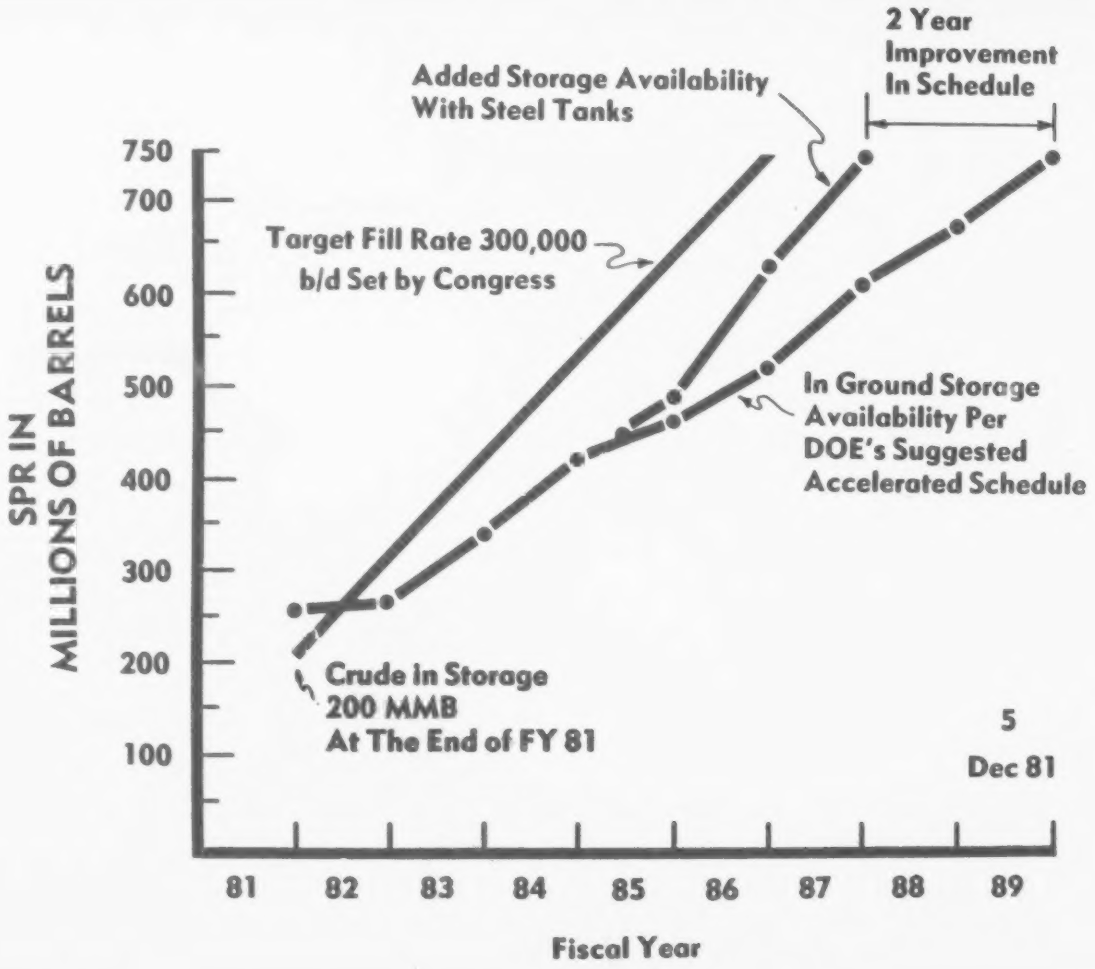
200
100
81
82
83
84
85
86
87
88
89
Fiscal Year
In Ground Storage
Availability Per
DOE's Suggested
Accelerated Schedule
2
Dec 81


SPR IN
MILLIONS OF BARRELS
750
700
600
500
400
300
200
100
Target Fill Rate 300,000 b/d Set by Congress
In Ground Storage Availability Per DOE's Suggested Accelerated Schedule
Crude in Storage 200 MMB At The End of FY 81
3
Dec 81
81
82
83
84
85
86
87
88
89
Fiscal Year


SPR IN
MILLIONS OF BARRELS
750
700
600
500
400
300
200
100
81
82
83
84
85
86
87
88
89
Fiscal Year
Storage In Steel
Tanks Availability
(3 Sites at 50 MMB Each)

4

Dec 81


2 Year
Improvement
In Schedule
Added Storage Availability
With Steel Tanks
Target Fill Rate 300,000
b/d Set by Congress
In Ground Storage
Availability Per
DOE's Suggested
Accelerated Schedule
Crude In Storage
200 MMB
At The End of FY 81
5
Dec 81
SPR IN
MILLIONS OF BARRELS
750
700
600
500
400
300
200
100
81
82
83
84
85
86
87
88
89
Fiscal Year

APPENDIX - C

TABLE 1

COST ESTIMATES FOR A 50-MMB STEEL TANK STORAGE FACILITY

(All costs in Jan. 1982 Dollars)

Date February 1982

($ in thousands)

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	TOTAL
PLANNING/EIS/PERMITS	1,250	250					$ 1,500
REAL ESTATE	500	8,300					8,800
DESIGN	2,000	1,500					3,500
CONSTRUCTION MANAGEMENT	By DOE	By DOE	By DOE	By DOE	By DOE	By DOE	By DOE
Facil (elect, mech & civil)		6,020	27,300	29,270	23,500	3,530	89,620
Storage Tanks (incl Foundations)		31,640	78,230	80,990	56,840	6,600	254,300
Pipelines		--	--	--	--	--	--
Power		140	630	810	550	150	2,280
O&M THRU FILL	--	--	--	By DOE	By DOE	By DOE	By DOE
CONSTRUCTION MANAGEMENT (COE or DOE staff)	By DOE	By DOE	By DOE	By DOE	By DOE	By DOE	By DOE

TOTAL COST EXCLUDING O&M AND CONSTRUCTION MANAGEMENT $360,000 ($7.20/Bbl)

NOTES

1) Real Estate Estimate based on 1100 acres at $8,000/acre.

2) The Costs shown for "Planning, EIS & Permits" represents Contractor assistance to the DOE in obtaining such permits and approvals.

3) Above Pricing includes Contractor supervision of intial fill on a module by module basis (5MMB per module). All other O&M Costs to be borne by DOE.

APPENDIX - D

DESCRIPTION OF 50MMB FACILITY

1. The facility consists of:

   a) 40 - 403 foot diameter by 60 foot high Type 5 pontoon floating roof tanks.

   b) Capacity of each tank is 1.25 MM Bbls.

   c) Facility requires approximately 1100 acres of land area.

   d) Foundations shall consist of compacted fill covered by an oiled sand cushion and surrounded by a crushed stone ringwall.

   e) Design fill rate is 350,000 Bbl per day. Design Pumpout rate is 266,750 Bbl per day.

   f) All product entering and leaving the facility will be monitored by a flow meter and recorded in the terminal control room.

   g) Security will be provided by fencing using a microwave intrusion detector system and by a television monitoring system consisting of eight remote control T.V. cameras and monitors.

   h) Fire protection will be provided by a combination of wet fire protection via a hydrant system, a fixed foam system for the storage tank seal area and the product pump areas, dry chemical extinguishers provided as both hand held and wheeled units, and a detection system located throughout the building area.

2. Present steel deliveries indicate that material would start arriving at fabrication plants within 10 to 12 weeks from date of contract. Therefore, the ordering of material, delivery to plants, fabrication and shipment of fabricated material could all be accomplished so that tank construction on Module 1 can proceed within six months from receipt of E.I.S. approval and all necessary permits.

   The required site clearing, grading, and construction of foundations for the tanks in Module 1 would also be completed in this six month period.

   The attached bar chart schedule shows construction of the tanks for Module 1 starting in July of 1983 with the module being completed and ready to receive oil by the first of April, 1985.

   The schedule shows that work would start on a new module area every 3 to 4 months and that about 12 tanks would be worked on at any one time. The testing, painting, and completion of piping would follow the tank construction after which three months would be allowed for commissioning prior to fill.

3. The pricing includes for Contractor participation in assisting the DOE in obtaining necessary permits and preparation of the Environmental Impact Statement.

4. The pricing and scheduling attached is based on completing the facility in 5MMB modules and turning each module over to the DOE upon completion prior to fill. Operation and maintenance from this point forward would be by DOE. However, Contractor will provide technical assistance and/or supervision during fill and will be responsible during this period for seeing that facility performs as designed. As the modules are turned over temporary security precautions will be taken to isolate the completed work from that still under construction.

5. The land pricing shown is based on a conservative figure of $8,000 an acre. It would be hoped, however, that sufficient government property near existing major crude arteries could be located to avoid purchasing of additional land which would not only reduce the cost somewhat, but also accelerate schedule.

6. The pricing and scheduling are based on Contractor designing, supplying, constructing, testing and commissioning the complete facility. Contracting could be on a lump sum basis, subject only to escalation.

APPENDIX - E

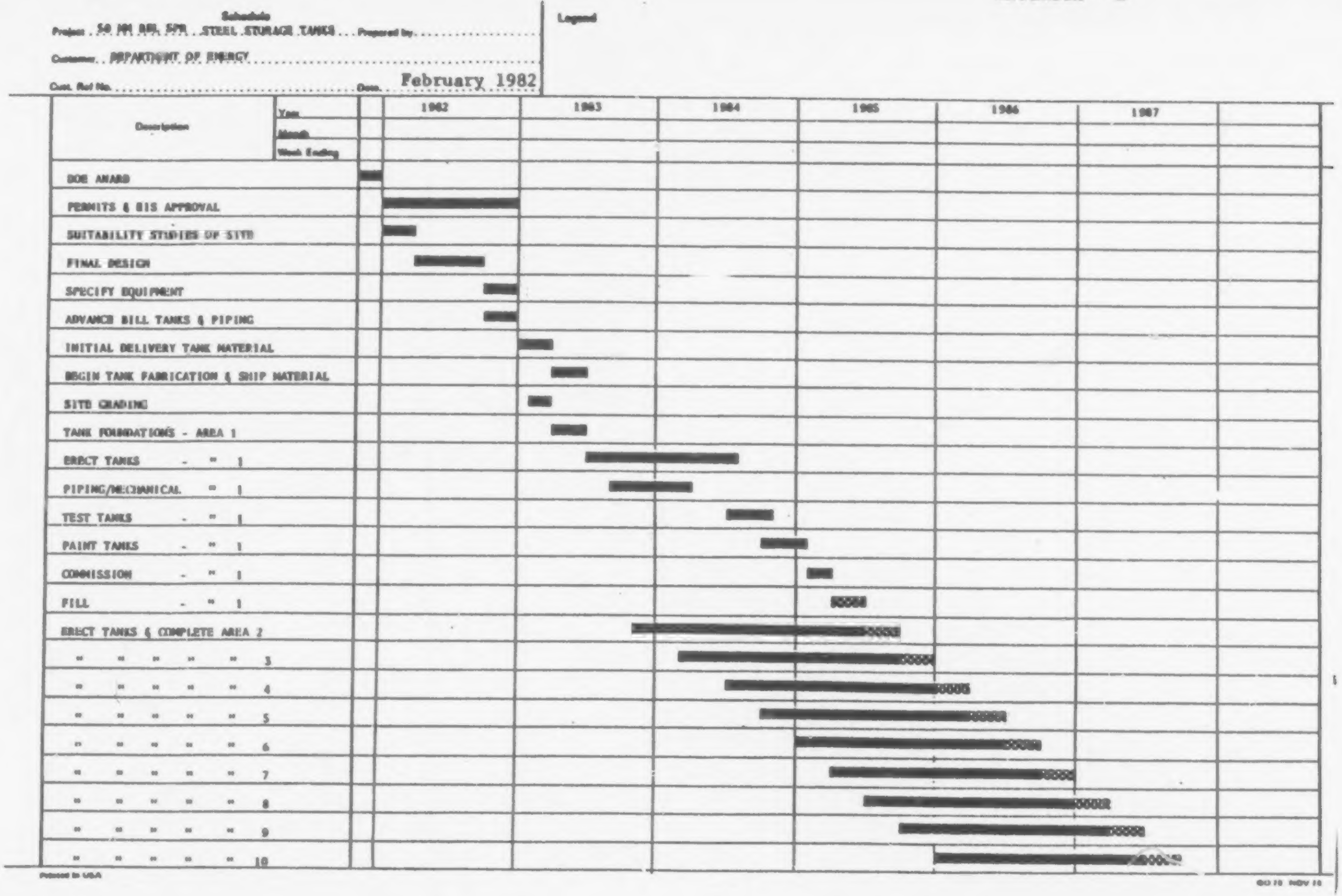
SCHEDULE FOR 50-MM BBL SPR TERMINAL

Attached is the construction schedule for a 50-MMB facility.

This schedule is based on the following conditions:

1. The site is located adjacent to an existing crude pipeline and is reasonably level with soil bearing conditions adequate to allow the construction of tanks 403' in diameter and 60' in height. Foundations to be gravel berm and oiled sand cushion. No allowance for rock excavation or measures to overcome poor soil conditions have been considered.
2. DOE award of January 1, 1982.
3. Site selection with suitability studies complete by April 1, 1982.
4. Final design, advanced billing of tank material, piping and equipment complete by January 1, 1983.
5. Permits and environmental impact approvals complete by January 1, 1983.
6. Release by January 1, 1983 to place orders for steel, equipment, detail engineering of tanks and release of civil subcontractors.
7. A Southern U.S. location.

APPENDIX - E


Schedule
Project 50 MM BBL SPR STEEL STORAGE TANKS
Prepared by
Customer DEPARTMENT OF ENERGY
Cust. Ref No.
Date February 1982
Legend
Description
Year
Month
Week Ending
1982
1983
1984
1985
1986
1987
DOE AWARD
PERMITS & EIS APPROVAL
SUITABILITY STUDIES OF SITE
FINAL DESIGN
SPECIFY EQUIPMENT
ADVANCE BILL TANKS & PIPING
INITIAL DELIVERY TANK MATERIAL
BEGIN TANK FABRICATION & SHIP MATERIAL
SITE GRADING
TANK FOUNDATIONS - AREA 1
ERECT TANKS - " 1
PIPING/MECHANICAL " 1
TEST TANKS - " 1
PAINT TANKS - " 1
COMMISSION - " 1
FILL - " 1
ERECT TANKS & COMPLETE AREA 2
" " " " " 3
" " " " " 4
" " " " " 5
" " " " " 6
" " " " " 7
" " " " " 8
" " " " " 9
" " " " " 10
Printed in USA

SECTION - 1

EXECUTIVE SUMMARY

EARLY LAST YEAR, CONGRESS DIRECTED THE PRESIDENT TO 'SEEK TO UNDERTAKE' AN AVERAGE OIL FILL RATE OF 300,000 BARRELS PER DAY FOR THE NATIONS STRATEGIC PETROLEUM RESERVE. AT THE TIME OF THIS DIRECTIVE, HOWEVER, THE BUDGETED STORAGE DEVELOPMENT PROGRAM WOULD RESTRICT FILL TO AN AVERAGE OF 189,000 BPD.

THE DOE UNDERTOOK A STUDY TO LOOK AT VARIOUS POSSIBILITIES FOR ACCELERATING THE PROGRAM. THEIR FINDINGS WERE INCLUDED IN A REPORT DATED JULY 1981 (SEE SECTION 4 OF THIS BOOKLET).

IN BRIEF, THE DOE'S REPORT CONCLUDES THAT LITTLE CAN BE DONE TO ACCELERATE FACILITY DEVELOPMENT. IT ALSO CONCLUDES THAT THE COMPOSITION OF THE RESERVE AS ORIGINALLY PLANNED IS STILL THE PREFERRED COMPOSITION. THIS COMPOSITION CONSISTS OF A 'BASE MODULE' OF 580MMB WHICH IS TOO FAR ALONG IN DEVELOPMENT TO CHANGE, PLUS A 30MMB EXPANSION AT WEST HACKBERRY AND A NEW 140MMB "GRASS ROOTS" SOLUTION MINED DEVELOPMENT AT BIG HILL, TEXAS.

THE FOLLOWING COMPARES THE FY 1982 BUDGETED PROGRAM WITH THE SLIGHTLY ACCELERATED PROGRAM AS CONTAINED IN THE DOE'S STUDY.

OIL FILL CAPACITY
(CUMULATIVE MMB, END OF FISCAL YEAR)

	1982	1983	1984	1985	1986	1987	1988	1989
1. FY 1982 BUDGET	261	331	398	409	481	605	687	750
2. DOE'S ACCELERATED PROGRAM	267	343	417	456	538	611	670	750

SPFA HAS STUDIED THE EFFECT A QUANTITY OF STEEL TANKS WOULD HAVE ON THE PROGRAM'S SCHEDULE. THE FOLLOWING SUMMARIZES ITS FINDINGS:

BY REPLACING THE BIG HILL SALT DOME WITH THREE 50MMB STEEL TANK TERMINALS, TWO YEARS CAN BE CUT FROM THE CURRENT FILL SCHEDULE.

THIS ACCELERATION WOULD PERMIT AN AVERAGE DAILY FILL THROUGH COMPLETION OF THE 750MMB PROGRAM OF 265,000 BPD OR 88 PERCENT OF THAT TARGETED BY CONGRESS. THE CUMULATIVE AVAILABLE CAPACITY AT THE END OF EACH FISCAL YEAR IN RELATION TO THE DOE'S ACCELERATED PROGRAM WOULD BE AS FOLLOWS:

OIL FILL CAPACITY
(CUMULATIVE MMB, END OF FISCAL YEAR)

	1982	1983	1984	1985	1986	1987	1988	1989
ALT. WITH STEEL TKS.	267	343	417	486	628	750	---	---
DOE'S ACCELERATED PROGRAM	267	343	417	456	538	611	670	750

THE CHARTS ATTACHED (CONTAINED IN APPENDIX B TO THE INTRODUCTION OF THIS BOOKLET) GRAPHICALLY ILLUSTRATE THE EFFECT STEEL TANKAGE COULD HAVE ON THE OVERALL FILL PROGRAM.

IN ADDITION TO OFFERING EARLY COMPLETION, STEEL TANKAGE WOULD BE COST EFFECTIVE WHEN CONSIDERING THE COST OF FACILITY DEVELOPMENT TOGETHER WITH THE COST OF THE FILL. THE REASON BEING SIMPLY THAT EARLY COMPLETION OF STORAGE PERMITS EARLY

PURCHASE OF OIL - AT PRESUMABLY LOWER COST. THE CORPS OF ENGINEERS' RESPONSE TO A CONGRESSIONAL INQUIRY (ATTACHED IN SECTION 3) HEREIN, CLEARLY SUPPORTS THIS STATEMENT.

THE DOE REPORT OF JULY 1981 ALSO SUPPORTS THE COST EFFECTIVENESS OF STEEL TANKAGE CONSIDERING 'NOMINAL' (ACTUAL OUTLAY OR ESCALATED) DOLLARS. HOWEVER, THE REPORT ALSO CONSIDERS A 'PRESENT VALUE' INVESTMENT ANALYSIS WHICH CONCLUDES THAT STEEL TANKS ARE NOT COST EFFECTIVE.

IN ARRIVING AT THE SO CALLED 'PRESENT VALUE', THE DOE ASSUMES AN ANNUAL REAL GROWTH IN OIL PRICING OF ONLY 3 PERCENT WHILE SETTING THE REAL DISCOUNT RATE AT 10 PERCENT. THIS RELATIONSHIP OF GROWTH TO DISCOUNT RATE, PENALIZES EARLY FACILITY COMPLETION AS ACKNOWLEDGED IN THE DOE REPORT. (SEE SECTION 4, PAGE III-4)

THE PRESENT VALUE INVESTMENT ANALYSIS SEEMS ONLY TO POINT OUT THAT STOCK PILING OF OIL CANNOT BE JUSTIFIED BY THE POTENTIAL RETURN ON INVESTMENT. RATHER, IT IS INTENDED TO BE INSURANCE PROTECTION AGAINST A POTENTIAL LOSS OF $200 IN GNP FOR EACH UNAVAILABLE BARREL DURING A SUPPLY SHORTAGE SITUATION.

ALTHOUGH THERE MAY BE SEVERAL CONSIDERATIONS IN THE FINAL SELECTION OF A STORAGE FACILITY, SURELY TWO OF THE MOST IMPORTANT ARE, EARLY COMPLETION AND TOTAL BUDGET OUTLAY DOLLARS. STEEL TANKAGE RATE WELL ON BOTH ACCOUNTS.

IN ADDITION TO THE FOREGOING COST AND SCHEDULE ADVANTAGES, A QUANTITY OF ABOVE GROUND STORAGE WOULD COMPLEMENT THE PRESENT IN-GROUND RESERVE BY ADDING OPERATIONAL FLEXIBILITY TO THE SPR PROGRAM. IT WOULD ALSO BE A GREAT BOOST TO THE PRESENTLY DEPRESSED STEEL AND CONSTRUCTION INDUSTRIES.

SUCH A CHANGE IN THE PROGRAM WOULD HAVE TO TAKE PLACE QUICKLY TO TAKE ADVANTAGE OF THE FULL TWO YEAR ACCELERATION.

SECTION 2

THE FOLLOWING LISTS MANY OF THE FAVORABLE CONSIDERATIONS WHICH SHOULD BE GIVEN TO THE CONCEPT OF ABOVE GROUND STEEL STORAGE IN ADDITION TO THE COST EFFECTIVENESS AND SCHEDULING IMPROVEMENTS.

1. THE CONSTRUCTION OF ABOVE GROUND STEEL TANK TERMINALS WOULD REQUIRE FEWER DOE OR CORPS SUPERVISORY PEOPLE. THE CONTRACTOR WOULD PROVIDE COMPLETE ENGINEERING AND OUTSIDE CONSULTING WOULD NOT BE REQUIRED.

2. ABOVE GROUND STORAGE HAS ADVANTAGES IN GRAVITY FLOW WHICH RESULTS IN LOW POWER REQUIREMENTS.

3. EXCEPT FOR A FEW PUDDLES, ALL OF THE CRUDE IN STORAGE IS RECOVERABLE FROM ABOVE GROUND STEEL TANKS.

4. ABOVE GROUND STEEL TANKS COULD BE USED TO STORE PRODUCTS OTHER THAN CRUDE OIL.

5. IF THE GOVERNMENT EVER DECIDED TO DISPOSE OF THE RESERVE, ABOVE GROUND TERMINALS COULD BE SOLD OR WOULD HAVE CONSIDERABLE SCRAP VALUE.

6. THE CRUDE IN ABOVE GROUND STEEL TANKS IS STORED AT ATMOSPHERIC PRESSURE, THEREBY ELIMINATING ANY RISKS OF BLOWOUTS.

7. VARIOUS GRADES OF CRUDE AND PRODUCTS CAN BE SEGREGATED IN ABOVE GROUND TANKS ALLOWING OPERATING FLEXIBILITY.

8. REGULAR INSPECTION FOR POSSIBLE LEAKS IN ABOVE GROUND STEEL TANKS IS VISIBLE AND EASILY REPAIRABLE. ABOVE GROUND STORAGE WOULD BE IN MANY TANKS, SO THE RISK OF A CATASTROPHIC TYPE LOSS WOULD BE REMOTE.

9. THE CRUDE COULD BE STORED IN AREAS AROUND THE U.S. CLOSE TO THE POINTS OF USE, THEREBY RELIEVING SOME OF THE REGIONAL PROBLEMS IN CASE OF EMERGENCY DRAWDOWN.

10. DISPERSAL OF THE RESERVE IS ONE OF THE BEST WAYS TO PRESERVE THE SECURITY OF THE CRUDE STORAGE.

11. THE NUMBER OF DRAWDOWNS FOR ABOVE GROUND STEEL TANKS IS ALMOST UNLIMITED. IT WOULD BE DETERMINED BY THE LIFE OF THE TANKS.

12. SUFFICIENT GOVERNMENT OWNED LAND COULD BE MADE AVAILABLE AT VARIOUS SITES WHICH WOULD BE A GREAT ASSISTANCE IN THE PERMITTING AND THE LAND ACQUISITION SCHEDULES.

13. AT THIS TIME OF UNEMPLOYMENT, THESE ABOVE GROUND STEEL TANK TERMINALS WOULD PROVIDE A GOOD BOOST TO THE U.S. STEEL AND CONSTRUCTION INDUSTRIES. 100MMB OF STORAGE WOULD REQUIRE APPROXIMATELY 300M TONS OF STEEL PLATE WITH THE ASSOCIATED MANHOURS OF WORK IN MANY INDUSTRIES.

SECTION 3

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO
ATTENTION OF:
DAEN-MPE

Honorable Carroll Hubbard
House of Representatives
Washington, DC 20515

Dear Mr. Hubbard:

This is a followup to the interim response on correspondence from Mr. A. A. Albertson, Vice President, CBI Industries Inc. regarding the Strategic Petroleum Reserve.

The Corps provides DOE with professional management and technical services in support of the development of the Strategic Petroleum Reserve under a Master Interagency Agreement since early 1979. The primary role of the Corps as deliniated in the MIA is to manage the design and construction of the SPR's expansion from Phase II to the 750MMB total for Phase III. Under this agreement we participated in the Source Evaluation Board for the competitive turnkey solicitation which was intended to meet the Phase III requirements; conducted planning studies for the Regional Reserve; and developed cost and schedule data for above ground storage facilities. The above ground storage cost and schedule estimates were provided to DOE for use in the acceleration study.

The information and cost comparisons contained in Mr. Albertson's inquiry have been evaluated. In order to fully evaluate the data, we obtained from DOE the Acceleration Report, dated July 1981 and analyzed it along with other data we have received. Comparisons of the various schedules and cost data for development of 100MMB site/storage capacity show the following:

Schedule Comparison

	MMB in Capacity Development by Fiscal Year						
Source & Date	FY-84	FY-85	FY-86	FY-87	FY-88	FY-89	TOTAL
SOLUTION MINED SITE							
DOE - Mar 81	-	-	-	13	47	40	100
Accel Rpt - 81	-	-	1	24	75		100

Source & Date	FY-84	FY-85	FY-86	FY-87	FY-88	FY-89	TOTAL
	MMB in Capacity Development by Fiscal Year						
STEEL TANKS							
White Castle - 81	-	24	36	32	8		100
Corps Est - Mar 81	10	55	35				100
Corps Est - Jun 81	10	50	40				100
Accel Rpt - Jul 81	-	24	36	32	8		100

COST COMPARISON - $/BBL

SOURCE	YEAR ON WHICH $ BASED	30MMB	40MMB	100MMB	140MMB
SOLUTION MINED					
Turnkey	1980	---	---	6.72	5.25
Accel Rpt	1981	---	---	5.16	4.04
STEEL TANKS					
Turnkey	1980	6.97	6.43	---	---
White Castle	1980	8.50	8.00	---	---
Mar Corps Est	1981	7.71	7.59	7.23	---
Jun Corps Est	1981	8.25	8.13	7.71	---
Accel Rpt	1981	9.90	8.98	---	---

The Acceleration Report analysis for steel tanks appears to be based on what is referred to as White Castle in the above comparisons. This data was prepared and withdrawn by the Corps in March 1981. This schedule did not represent an accelerated effort and produced excessive cost growth due to inflation factors.

It was our understanding that there was a lack of capacity in the FY 84-86 time frame (See Acceleration Report, Page 1-3, Inclosure 1). Schedule and funding profiles were developed to meet this capacity shortfall. This info was provided to DOE in March to meet a June 1981 start, and in June to meet an October 1981 start date for the facility acquisition process. The Acceleration Report did not use either the March or June schedule for steel tanks which would provide the earliest fill period, the lowest construction cost by reducing cost growth due to escalation and, assuming oil was available, the savings on any price increases for oil. We do not know what costs are included in the Acceleration Report for the Big Hill solution mined site and therefore are unable to compare the lower 1981 cost predicted by the report.

Using a storage capacity of 100MMB, a comparison of the two storage alternatives is provided:

100MMB COMPARISON

COST	STEEL TANKS	SOLUTION MINED
Cost 81 $/BBL	8.25	5.16
Cost Current Year $	10.20	6.88
Fac Cost 81 $ (MM)	825	516
Oil Cost 81 $ (MM)	4,217	4,607
Fac Cost Current Year $ (MM)	1,020	712
Oil Cost Current Year $ (MM)	5,687	6,832
SCHEDULE		
Initial Capacity Available	FY-84	FY-86
Initial Amount Available	10MMB	1MMB
Complete Capacity Available	FY-86	FY-88

The above comparisons show the following:

a. Combined acquisition expenditure costs for facilities and oil is less in steel tanks.

b. Steel tanks additionally represent a two year schedule improvement over solution mined sites.

Further cost point consideration would be merited for uncertainties removed by use of the steel tank construction, as follows:

a. Programmatic risk reduced through schedule acceleration.

b. One hundred percent oil recovery in steel tanks versus unknown recovery loss in solution-mined sites. DOE admits to a 1.5% recovery loss. A 5% loss is regarded as more realistic based upon the many unknowns inherent in long-term storage in solution-mined cavities.

c. Regional storage location flexibility.

d. Storage vessels suitable for crude and product storage.

The information available supports the contention that storage by the solution-mined process may not be the most cost effective. There may be factors other than schedule and acquisition costs affecting the decision process which are not available to the Corps. It is suggested that the DOE be contacted for appropriate comments on the above.

If we may be of further assistance to you in responding to Mr. Albertson's inquiry, please advise.

Sincerely,

1 Incl
As stated

JEROME B. HILMES
Brigadier General, USA
Deputy Director for Facilities
Engineering and Housing
Directorate of Military Programs

estimates for Phase II in this paper are predicated on approval of this permit modification.

Phase III, in the FY 1982 budget, was planned to include the following elements:

- Further expansion of Bryan Mound by 40 MMB.
- Further expansion of West Hackberry by 30 MMB.
- Development of a new 140 MMB "grass roots" solution-mined site.

Because of the aforementioned increase in the brine disposal rate at Bryan Mound, the Phase III expansion of Bryan Mound will be cost-effective and timely in relation to the Phase III expansion of West Hackberry. Therefore, for purposes of this review, we have assumed a "Base Module" of 580 MMB, which will remain unchanged throughout the analysis. The base system consists of the following elements:

	(MMB)
Phase I	250
Phase II	290
Phase III Bryan Mound	40
Base System Total	580

Table I compares this Base Module to the FY 1982 budget baseline estimates for the oil fill capability schedule for the 750 MMB system. It illustrates the significant fill capability gains that can be achieved through 1986 through the revisions in the Bryan Mound brine disposal rate. Some of these gains are also attributable to the deletion of West Hackberry Phase III which, in the FY 1982 baseline, was proposed for development simultaneously (termed coexpansion) with West Hackberry Phase II. The coexpansion of West Hackberry Phases II and III actually results in a temporary retardation of Phase II fill capability in the 1984-1986 period.

The 580 MMB Base Module is held constant throughout the analysis with increments of storage development added thereto.

FACT SHEET

5 October 1981

SUBJECT: Above Ground Storage Facilities for Strategic Petroleum Reserve

PURPOSE:

This is to provide basis for response to Congressional inquiries regarding correspondence from Mr. A. A. Albertson, Vice President, CBI Industries, Inc. in connection with steel tank storage facilities for the Strategic Petroluem Reserve. These Congressional inquiries have centered around information which the Corps of Engineers may have provided to DOE.

BACKGROUND

The Corps provides DOE with professional management and technical services in support of the development of the Strategic Petroleum Reserve under a Master Interagency Agreement (MIA dated March 1979). The primary role of the Corps as delineated in the MIA is to manage the design and construction of the SPR's expansion from Phase II to the 750MMB total for Phase III. Under this agreement we participated in the Source Evaluation Board for the competitive turnkey solicitation which was intended to meet the Phase III requirements; conducted planning studies for the Regional Reserve; and developed cost and schedule data for above ground storage facilities. Above ground storage cost and schedule estimates were provided to DOE for use in their study of alternatives for accelerating storage facilities development.

FACTS

The information provided to DOE for above ground storage was as follows:

SCHEDULE

	MMB in Capacity Development by Fiscal Year						
Source	FY-84	FY-85	FY-86	FY-87	FY-88	FY-89	TOTAL
White Castle - 81	-	24	36	32	8		100
Corps Est - Mar 81	10	55	35				100
Corps Est - Jun 81	10	50	40				100

COST - $/BBL

SOURCE	YEAR ON WHICH $ BASED	30MMB	40MMB	100MMB
White Castle	1980	8.50	8.00	---
Mar Corps Est	1981	7.71	7.59	7.23
Jun Corps Est	1981	8.25	8.13	7.71

5 October 1981

The information referred to as White Castle in the above tables was prepared and withdrawn by the Corps in March 1981. This schedule did not represent an accelerated effort and produced excessive cost growth due to inflation factors.

The Corps was requested to respond to a situation which indicated a lack of capacity in the FY 84-86 time frame. Schedule and funding profiles were developed to meet this capacity shortfall. This information was provided to DOE in March to meet a June 1981 start, and revised in June to meet an October 1981 start date for the facility acquisition process.

DISCUSSION

The information and cost comparisons contained in Mr. Albertson's inquiry have been evaluated at the request of Congressional Staffers. In order to fully evaluate the data, we obtained from DOE the Acceleration Report, dated July 1981 and analyzed it along with other data we have received or developed in support of DOE. Comparisons of the various schedules and cost data show the following:

SCHEDULE COMPARISON

	MMB in Capacity Development by Fiscal Year						
Source	FY-84	FY-85	FY-86	FY-87	FY-88	FY-89	TOTAL
SOLUTION MINED SITE							
DOE - Mar 81	-	-	-	13	47	40	100
Accel Rpt - 81	-	-	1	24	75		100
Accel Rpt - 81	-	-	-	13	47	80	140

	MMB in Capacity Development by Fiscal Year						
Source	FY-84	FY-85	FY-86	FY-87	FY-88	FY-89	TOTAL
STEEL TANKS							
White Castle - 81	-	24	36	32	8		100
Corps Est - Mar 81	10	55	35				100
Corps Est - Jun 81	10	50	40				100
Accel Rpt - Jul 81	-	24	36	32	8		100

5 October 1981

COST COMPARISON - $/BBL

SOURCE	YEAR ON WHICH $ BASED	30MMB	40MMB	100MMB	140MMB
SOLUTION MINED					
Turnkey	1980	---	---	6.72	5.25
Accel Rpt	1981	---	---	5.16	4.04
STEEL TANKS					
Turnkey	1980	6.97	6.43	---	---
White Castle	1980	8.50	8.00	---	---
Mar Corps Est	1981	7.71	7.59	7.23	---
Jun Corps Est	1981	8.25	8.13	7.71	---
Accel Rpt	1981	9.90	8.98	---	---

The Acceleration Report did not use either the March or June schedule for steel tanks which would provide the earliest fill period, the lowest construction cost by reducing cost growth due to escalation and, assuming oil was available, the savings on any price increases for oil. We do not know what costs are included in the Acceleration Report for the Big Hill solution mined site and therefore are unable to compare the lower 1981 cost predicted by the report.

A comparison of the two storage alternatives for 100MMB is provided:

100MMB COMPARISON

COST	STEEL TANKS	SOLUTION MINED
Cost 81 $/BBL	8.25	5.16
Cost Current Year $	10.20	6.88
Fac Cost 81 $ (MM)	825	516
Oil Cost 81 $ (MM)	4,217	4,607
Fac Cost Current Year $ (MM)	1,020	712
Oil Cost Current Year $ (MM)	5,687	6,832

5 October 1981

SCHEDULE	STEEL TANKS	SOLUTION MINED
Initial Capacity Available	FY-84	FY-86
Initial Amount Available	10MMB	1MMB
Complete Capacity Available	FY-86	FY-88

The above comparisons show the following:

a. Combined acquisition expenditure costs for facilities and oil is less in steel tanks.

b. Steel tanks additionally represent a two year schedule improvement over solution mined sites.

Further cost point consideration would be merited for uncertainties removed by use of surface tank construction, as follows:

a. Programmatic risk reduced through schedule acceleration.

b. One hundred percent oil recovery in steel tanks versus unknown recovery loss in solution-mined sites. DOE designs to a 1.5% recovery loss. A larger loss is regarded as more realistic based upon the many unknowns inherent in long-term storage in solution-mined cavities.

c. Regional storage location flexibility.

d. Storage vessels suitable for crude and product storage.

J. Vincent/272-0795

FACT SHEET 19 October 1981

SUBJECT: Above Ground Storage Facilities for Strategic Petroleum Reserve

PURPOSE

This fact sheet is a supplement to the 5 October 1981 fact sheet subject as above. This fact sheet provides a comparison of a 140MMB storage in solution mined and above ground storage sites.

FACTS

This comparison uses solution mined data for the Big Hill site found in the DOE Acceleration Report dated July 1981 and the June 1981 Corps estimate for above ground storage expanded from 100MMB to 140MMB.

140MMB COMPARISON

COST	STEEL TANKS	SOLUTION MINED
Cost 81 $/BBL	7.23	4.04
Cost Current Year $	9.90	5.71
Fac Cost 81 $ (MM)	1,012	566
Oil Cost 81 $ (MM)	5,942	6,593
Fac Cost Current Year $ (MM)	1,387	799
Oil Cost Current Year $ (MM)	7,752	10,107
SCHEDULE		
Initial Capacity Available	FY-84	FY-87
Initial Amount Available	30MMB	13MMB
Complete Capacity Available	FY-86	FY-89

J. Vincent/272-0397

SECTION 4

STRATEGIC PETROLEUM RESERVE ACCELERATION
REPORT TO THE SECRETARY

July 1981

Strategic Planning and Analysis Division
Strategic Petroleum Reserve Office

PREFACE

This study assesses the relative effects of specific Strategic Petroleum Reserve configuration and schedule alternatives. It employs strategic and economic assumptions specifically designed to illustrate differences among alternatives. The assumptions do not, in their absolute form, necessarily represent official Department of Energy projections or planning parameters.

EXECUTIVE SUMMARY AND CONCLUSIONS

SUMMARY

The purpose of this Report is to provide information for use by the Department of Energy and the Executive Office of the President for deciding on changes to the development plan for the Strategic Petroleum Reserve (SPR) presented in the March 10, 1981 President's Budget for 1982. This Report is intended to support the needs for the FY 1983 Planning, Programming and Budgeting process and to satisfy a request by the Office of Management and Budget of March 24, 1981 for a study by August 1 "of all alternatives for accelerating the facilities development schedule so as to increase U.S. protection against supply interruptions in the near term."

The prior Administration had approved completion of a 750 MMB government-owned, centralized crude oil storage program in 1989 with 420 MMB in storage capacity available by the end of calendar year 1985. Under this plan the development of the Reserve would take place in three phases: Phase I, consisting of a 250 MMB storage capacity, Phase II, consisting of a 290 MMB storage capacity, and Phase III encompassing a remaining 210 MMB storage capacity.

Phase I has been completed. Moreover, over 75 percent of the $702 million appropriated for Phase II has already been obligated. As a consequence, this part of SPR development is treated as a given, being included on all the alternatives considered.

Phase III development is scheduled to commence in FY 1982. One element of the Phase III plan--the 40 MMB expansion of Bryan Mound--was considered as given because of the clear cost-effectiveness of this expansion. The other two Phase III elements--the 30 MMB expansion of West Hackberry and the development of a new 140 MMB site at Big Hill--were not considered as given. Rather, they were evaluated along with other facilities development options.

In light of these above considerations, a 580 MMB base module consisting of Phase I (250 MMB), Phase II (290 MMB), and Phase III, (Bryan Mound) (40 MMB), was developed. Beyond this 580 MMB base module, additional incremental modules were evaluated. These additional incremental modules are summarized in the following table:

Summary of Incremental Modules

Increment	Size (MMB)
(1) West Hackberry, Phase III	
a. Coexpansion with Phase II	30
b. Deferred expansion	30
(2) Big Hill	
a. 100 MMB	100
b. 140 MMB	140
(3) New Solution-Mined Site	120
(4) Cote Blanche	40
(5) Steel Tanks	
a. 40 MMB (FY 82 Budget)	40
b. 30 MMB (FY 83 Budget)	30

Costs per barrel for each of these increments were compared in terms of budget and real dollars and present value terms. The above increments were also evaluated according to several measures that consider both costs (facility and oil costs) and benefits represented as either incremental capacity added annually or cumulative barrels of capacity at the end of each year.

The development schedules utilized for the study are based on the maximum development rate deemed technically feasible. The possibility of accelerating development by such measures as waiver of Federal environmental and procurement requirements and accelerating the procurement process was also examined. For the existing planned development, much of environmental and procurement work has been accomplished and therefore not at issue. For new development, it is not presently foreseeable that these requirements will be constraining in most cases. Thus, we can not at this time identify quantifiable gains which would be achieved through measures of this kind. However, it should be recognized that delays in schedules utilized for this study can result from environmental, procurement, or other problems and relief then may become necessary in order to maintain the schedules.

The criteria used for ranking these individual increments to the 580 MMB Base Module were as follows:

- minimization of the unit cost of facilities in nominal dollars, real dollars, and the present value of real dollars;
- minimization of real dollar program (oil plus facilities) cost per-barrel;
- maximization of the ratio of discounted facility capacity increments to present value of facilities costs, for all discount rates; and
- maximization of the ratios of discounted barrel-years of protection to total program investment value (present value of facilities and oil costs net of salvage value) up to, and including, benefit discount rates of 10 percent per year.

After the individual increments were ranked, five SPR systems alternatives were developed for further evaluation.

(1) a 750 MMB system--consisting of the Base Module (580 MMB); plus the 30 MMB coexpansion of West Hackberry; plus the development of 140 MMB capacity at Big Hill.

(2) a 790 MMB system--consisting of the above-mentioned 750 MMB system; plus Cote Blanche (40 MMB).

(3) an 890 MMB system--consisting of the above-mentioned 790 MMB system; plus 100 MMB of steel tanks.

(4) a 1,000 MMB system--consisting of the above-mentioned 890 system; plus a new 110 MMB solution-mined site.

(5) a 1,000 MMB system--consisting of the 890 MMB system defined in (3); plus 110 MMB of steel tanks.

These five SPR systems were evaluated in terms of their net benefit stemming from an oil supply shortfall. A computerized decision model--

developed for the Policy, Planning, and Analysis Office of the department by Professor Tom Teisberg, of MIT--was used to estimate these economic loss reductions.

The Teisberg model evaluated each of the SPR system alternatives in terms of net economic benefit implicit at various statistical assumed probabilities for an oil supply interruption occurring during the lifespan of the SPR project. The results of this evaluation are ranked ordinally in the table below with the alternative system expressing the largest net economic benefit being ranked number one.

Rank Ordering of the Results of the Teisberg Model Analysis
According to Size of Consumer Surplus Loss Avoided

Assumed Probability of Oil Supply Shortfall		System Project Alternatives				
Yearly	Project Life[1]	(1) 750	(2) 790	(3) 890	(4) 1,000	(5) 1,000
		(tight market)[2]				
0.0	0.0	N/A	N/A	N/A	N/A	N/A
1.0	.21	1	2	3	4	5
2.0	.38	1	2	3	4	5
3.0	.48	4	2	1	3	5
4.0	.62	5	4	3	1	2
5.0	.71	5	4	3	2	1
10.0	.92	5	4	3	2	1
15.0	.98	5	4	3	2	1
20.0	.99+	5	4	3	2	1
		(slack market)				
5.0	.71	5	4	3	2	1
10.0	.92	5	4	3	2	1
15.0	.98	5	4	3	2	1
20.0	.99+	5	4	3	2	1

[1] Project life of 24 years running from 1981 to 2004 inclusive; expresses the statistical chance of encountering at least one such oil supply shortfall.

[2] The terms "slack" and "tight" refer to alternative market conditions when SPR oil is being purchased. Under a slack market, such as at the present, SPR oil purchases do not increase market prices and thereby affect the cost to the U.S. economy or private sector oil imports. Under tight market conditions, SPR purchases do increase market prices and therefore represent a conservative assumption regarding the net economic benefits of various SPR system configurations

The above results indicate that increases in the assumed probability of a shortfall justify progressively greater SPR sizes.

CONCLUSIONS

This study yields the following conclusions:

(1) the 750 MMB program contained in the FY 82 budget cannot be further accelerated to any significant degree and its composition is the most cost-effective 750 MMB system.

(2) under most circumstances, Cote Blanche is the most attractive increment to the existing elements of the current 750 MMB system for expansion to 790 MMB.

(3) beyond a 790 MMB system, if protection against an oil supply interruption during the 1980's is sought, then steel tanks are preferred. However, if the protection desired extends through the entire century, then a new solution-mined site is more cost-effective.

(4) 1,000 MMB SPR is economically justified if the expected probability of an oil supply cut-off is at least 4 percent per year (implying a 62 percent likelihood of at least one such occurrence over the 24-year lifespan of the SPR project).

(5) then 790 MMB and 890 MMB systems are economically justified if the expected probability of an oil supply cut-off is at least 3 percent per year (implying a 48-percent probability of at least one shortfall during the project life).

CONTENTS

Section

EXECUTIVE SUMMARY

I. INTRODUCTION
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SECTION I

INTRODUCTION

PURPOSE OF THE REPORT

This Report was prepared for use by the Department of Energy and the Executive Office of the President in making decisions on whether to change the plan for Strategic Petroleum Reserve (SPR) development which was embodied in the March 10, 1981 President's Budget for FY 1982. It is intended to satisfy the needs of Department of Energy decision makers for the FY 1983 Planning, Programming, and Budgeting process and to satisfy the request of the Office of Management and Budget of March 24, 1981 to "prepare a study, by August 1, of alternatives for accelerating the facilities development schedule so as to increase U.S. protection against supply interruptions in the near term."

APPROACH TO THE PROBLEM

The current Administration inherited from the prior Administration a Strategic Petroleum Reserve (SPR) facilities development plan which would result in completion of a 750 MMB government-owned, centralized crude oil storage program in 1989, with 420 MMB in storage capacity available by the end of calendar year 1985. The Energy Policy and Conservation Act of 1975 had set a minimum target of 500 MMB in storage by the end of 1982, and the Carter Administration had, in the 1977 National Energy Plan and in SPR Plan Amendment No. 2, set a goal of 1 billion barrels in storage by 1985, and described a plan for a 750 MMB government-owned system to be completed by that year.

The reasons for the delays of prior years will not be discussed at length in this paper. Rather, we will focus on the remaining options available in 1981 for future decisions to alter the SPR development program.

The SPR program as set forth in the FY 1982 budget is being developed in three Phases. Phase I involved the conversion for hydrocarbon storage of existing salt caverns at five storage sites, plus the development of transportation facilities to connect the storage sites to major elements of the U.S. crude oil distribution system. In the FY 1982 budget, the capacity of Phase I was set at 248 MMB; in this report, due to more recent analysis, the Phase I capacity is rated at 250 MMB.

Phase I storage site development is complete and available for fill during the FY 1981-2 period, though limited facilities funding actions continue as the courts render judgment on the real-estate condemnation cases. Physically, Phase I capacity and schedule are considered as given for purposes of this review.

Phase II consists of a further 290 MMB in capacity developed at three of the Phase I storage sites: West Hackberry (160 MMB), Bryan Mound (120 MMB) and Bayou Choctow (10 MMB). Generally, Phase II expansions are being carried out through solution-mining (leaching) new storage capacity, involving the drilling of wells into the salt formation, the development of fresh water intake capabilities to inject fresh water into the salt, and the disposal of saturated brine. Of the $702 million estimated cost to complete Phase II, over 75 percent or $527 million has already been appropriated and will be obligated by the end of FY 1981. Surface facilities development is nearing completion and leaching has commenced at both Bryan Mound (in 1980) and West Hackberry (in 1981).

Given the sunk costs and progress to date on Phase II, this study does not consider alternatives for major changes to the basic plan for the configuration of Phase II. However, one opportunity for acceleration of a portion of Phase II has been identified. Since the brine disposal pipeline at Bryan Mound was designed for a higher flow rate then allowed by the current EPA discharge permit, the Department of Energy, in February, 1981, applied for a change in the permit to allow brine discharge into the Gulf of Mexico at a daily average rate of 980 MBD, in comparison to the current permitted rate of a maximum of 680 MBD on each day. Assuming approval of this application, the change in the terms of this permit plus the addition of some pumps late in 1981 will accelerate the completion of the Bryan Mound Phase II and, as discussed below, Phase III capacity. The revised schedule estimates for Phase II in this paper are predicated on approval of this permit modification.

Phase III, in the FY 1982 budget, was planned to include the following elements:

- Further expansion of Bryan Mound by 40 MMB.
- Further expansion of West Hackberry by 30 MMB.
- Development of a new 140 MMB "grass roots" solution-mined site.

Because of the aforementioned increase in the brine disposal rate at Bryan Mound, the Phase III expansion of Bryan Mound will be cost-effective and timely in relation to the Phase III expansion of West Hackberry. Therefore, for purposes of this review, we have assumed a "Base Module" of 580 MMB, which will remain unchanged throughout the analysis. The base system consists of the following elements:

	(MMB)
Phase I	250
Phase II	290
Phase III Bryan Mound	40
Base System Total	580

Table I compares this Base Module to the FY 1982 budget baseline estimates for the oil fill capability schedule for the 750 MMB system. It illustrates the significant fill capability gains that can be achieved through 1986 through the revisions in the Bryan Mound brine disposal rate. Some of these gains are also attributable to the deletion of West Hackberry Phase III which, in the FY 1982 baseline, was proposed for development simultaneously (termed coexpansion) with West Hackberry Phase II. The coexpansion of West Hackberry Phases II and III actually results in a temporary retardation of Phase II fill capability in the 1984-1986 period.

The 580 MMB Base Module is held constant throughout the analysis with increments of storage development added thereto.

Table I.1 Strategic Petroleum Reserve Fill Capability

Comparison of the FY 1982 Baseline to the Base Module
(Cumulative MMB, End of Fiscal Year)

	1981	1982	1983	1984	1985	1986	1987	1988	1989
FY 1982									
(a.) Baseline									
Phase I	248	248	248	248	248	248	248	248	248
Phase II	---	13	83	151	157	203	274	290	290
Phase II	---	---	---		4	30	83	149	212
Total	248	261	331	398	409	481	605	687	750
(b.) Base Module									
Phase I	250	250	250	250	250	250	250	250	250
Phase II	1	17	93	166	205	273	290	290	290
Phase III (BM)	---	---		1	12	40	40	40	40
Total	251	267	343	417	467	563	580	580	580
Percent/ (a) to (b)	0.99	0.98	0.97	0.95	0.88	0.55	1.04	1.18	1.29

Section II, backed up by the Appendix A, defines the alternative increments to the 580 MMB Base Module and presents the budget and fill schedule data associated with each.

Section III is an analysis of each alternative increment based on various evaluation measures. These measures compare benefits, represented by either annual or cumulative fill capability, to the present value of cost of facilities or facilities and oil. This is not a net economic benefits analysis because the costs and benefits are not presented in commensurable terms. Rather, Section III attempts to rank alternatives in terms of the relationship of the fill capability schedule to the present value of costs.

Section IV presents some overall system configuration alternatives combining the 580 MMB Base Module with the alternative facilities increments ranked in Section III.

Section V uses the Teisburg model to compare the net economic benefits of the alternative system configurations presented in Section IV.

SECTION II

DESCRIPTION OF ALTERNATIVE INCREMENTS TO THE BASE MODULE

OVERVIEW

This section describes the alternative SPR storage facility increments that could be added to the Base Module described in Section I.

The early (1974-75) National Petroleum Council Studies recommended that the SPR stockpile be stored in large salt caverns in the Gulf Coast area, and SPR planning by the Federal Energy Administration led to the identification of numerous salt dome formations along the Gulf Coast. The current 750 MMB SPR configuration is the result of a process of elimination among candidate salt domes using a specific set of criteria, among which facilities development cost emerged as a priority determinant in site selection.

From time to time during this process, there has been interest in finding alternative sites and/or storage media that would enhance the SPR schedule. In 1978 a rigorous process was initiated to obtain and evaluate industry offers to develop SPR storage facilties on a "turnkey" basis. This "turnkey" procurement was cancelled in 1979, basically because the curtailment of SPR oil fill by the Carter Administration made it unclear that it was worth spending money to accelerate facility capacity due to the potential that the facilities would be left temporarily unfilled, and because the "turnkey" proposals seemed to lack advantages over conventional site development.

Other proposals for alternative SPR facilities have been raised from time to time, including the use of conventional above-ground steel tanks, the leasing of storage capacity from the private sector, and the use of oil tankers for floating storage, a method employed by the Japanese government.

The government's procurement, environmental, and budget processes are such that there is a considerable delay from the time a concept is articulated to the time a funded construction project is underway. In addition to the passage of time for these processes to run their course, new uncertainties emerge about the basic viabilty of a new or different concept, just as the oil acquisition curtailment introduced new uncertainties into the SPR competitive turnkey procurement process.

Therefore, while not completely disregarding the possibility that there may, in fact, be some low-cost attractive schedule facilities alternatives "out there", we have confined our analysis to facilities options about which enough is known to permit decision making in 1981 with a relatively high degree of confidence. Specifically, we have looked at alternative configurations of development for the SPR projects that are within the 750 MMB FY 1982 baseline system but outside the 580 MMB base module. In addition, we have revisited the possibility, first raised about 5 years ago, of converting the Cote Blanche salt mine for oil storage. Finally, in part with the assistance of the Corps of Engineers, we have developed cost and schedule prototypes of two known methods of oil storage--development of another large underground salt dome site through solution-mining and development of some large but technically conventional steel tank storage sites.

The schedules for each increment are based on the maximum development rate deemed technically feasible. As mentioned previously, leaching rates, one of the principal determinants of schedule, are being accelerated to the full capability of brine disposal systems currently developed.

We have also reviewed the possibility of accelerating development of each alternative increment by administratively or legislatively waiving existing environmental, permitting, land acquisition and procurement requirements. However, while such factors could prove constraining, we presently can not quantify significant acceleration from such action for these reasons:

(1) A large number of these requirements on existing planned development will be satisfied by the end of FY 81.

(2) An environmental impact statement has already been prepared for Cote Blanche, a former "turnkey site", for 30 MMB. Only a supplemental to the existing EIS would be required for the 40 MMB site.

(3) New developments such as steel tanks and a new solution-mined site will not benefit from waiving requirements in these areas because they are not on the critical path or because so far as currently can be determined they are already at the maximum feasibile rate of development.

A more detailed assessment of the effect on the development schedule for each alternative increment of complying with existing requirements in these areas and the scheduling assumptions used are presented in Appendix B.

Not withstanding the above comments, waivers of environmental requirements could become desirable if any major impediments to acquiring approval to proceed with a given development should occur. However, such contingencies would apply across all alternatives and would be addressed on a case-by-case basis.

None of these alternatives is risk-free, but we have tried to build in reasonable contingency factors in cost and schedule estimates. The following is a brief description of each of these alternatives.

(1) FURTHER EXPANSION OF WEST HACKBERRY

West Hackberry is the largest planned SPR site; it now has a Phase I capacity of 48 MMB and is planned for expansion by 160 MMB as part of Phase II. Phase II leaching actually commenced in May 1981, the surface construction having been substantially completed during 1980 and early 1981. Adding three new caverns (30 MMB) to this site in Phase III, as planned in the 1982 budget, is a relatively straightforward matter of drilling additional wells, developing tie-ins to other site piping, electrical, and instrumentation systems, and using existing fresh water intake, brine disposal, and crude oil transportation infrastructure to complete the leach fill process.

Two expansion subalternatives have been identified:

(a) Coexpansion: This involves leaching the three Phase III caverns in tandem with the second group of Phase II caverns, resulting in operational efficiencies but retarding Phase II cavern development.

(b) Deferred leaching: This involves waiting for the Phase II caverns to be completed before leaching the Phase III caverns.

This decision does not have to be made until 1983, but we have used both subalternatives in the evaluation to permit a fair comparison of the West Hackberry increment to other alternatives.

(2) BIG HILL

The Big Hill salt dome was identified as a candidate SPR site very early in the SPR planning process. In the FY 1982 budget, it is proposed for development to a 140 MMB size as part of Phase III. Considerable environmental analyses have been completed on Big Hill, and a process has been established for selecting an architect/engineer. However, major capital commitments, such as land acquisition, have not yet been made so Big Hill was not included in the 580 MMB Base Module.

As with West Hackberry, two subalternatives have been identified for Big Hill.

(a) 100 MMB: This involves the development of only 10 caverns at Big Hill, without a change in the overall site brine disposal capabilities, permitting the average cavern to develop at a faster rate. However, since the infrastructure is about the same as for the 140 MMB size, the unit costs of developing a 100 MMB size tend to be higher.

(b) 140 MMB: This is the proposal in the FY 1982 budget.

We have not evaluated a reconfiguration of the 140 MMB project, which would entail leaching the first 100 MMB at a faster rate as in subalternative (a), deferring leaching of the other 40 MMB. The decision would not need to be made for several years. The availability of the FY 1982 budget funding requested for Big Hill is assumed for both cases.

(3) NEW SOLUTION-MINED SITE

This entails the development of a new solution-mined SPR facility, beginning in FY 1983, to the level of 120 MMB, at a site which has not been identified and where no site-specific cost, design schedule, or environmental analyses have been conducted.

(4) COTE BLANCHE MINE

This is the conversion to hydrocarbon storage of the Cote Blanche mine, a conventional salt mine near the existing SPR Weeks Island site in southern Louisiana.

Cote Blanche is an operating salt mine that had been identified some years ago and considered for SPR use. The owners and operators were contacted at that time and some negotiations were conducted until late 1979. The fact that the property is owned by two family trusts which have been unwilling to sell, and that the operator's lease rights are limited, made it very difficult to negotiate a satisfactory acquisition. Condemnation of the site could prove necessary and it would be difficult to assure continued salt mining operations elsewhere by the current operator. Unemployment and lost salt production could result, and the operator, a Canadian company, previously threatened diplomatic repercussions. Also, the taking of this site could be alleged to violate a February, 1978 "best efforts" agreement between former DOE Deputy Secretary O'Leary and Louisiana's then--Governor Edwards that "DOE use of . . . salt Dome(s) . . . will be acceptable to the State, so long as no employees of industries utilizing the Domes are displaced in their jobs."

Some years ago, Cote Blanche was thought to have a capacity of over 30 MMB, but we have estimated the future capacity at 40 MMB, based on continued mining in the interim.

(5) STEEL TANKS

Working with the Corps of Engineers, we have developed prototype cost and schedule estimates for both a 40 MMB and a 30 MMB steel tank storage site. In both cases we assume the use of large (1.25 MMB) steel tanks developed in 5 MMB modules in series. The first module on a site thus becomes available for fill while subsequent modules are being developed.

For the 40 MMB module we are assuming nearly full-funding in FY 1982 to be followed by funding for the 30 MMB module in FY 1983. Changes in funding and schedule for both are possible, and further increments can be added to this 70 MMB to achieve higher levels. However, while site selection activities have not been undertaken, one could assume that each incremental site required to achieve higher total storage levels would involve greater cost/schedule/environmental trade-offs. A 40 MMB steel tank storage site, although much smaller than the average SPR Base Module site, is a visibly large government development activity.

Table II.1 sets forth the oil fill capability schedule for each increment to the Base Module. Table II.2 sets forth the facilities development budget requirements for each, and Table II.3 sets forth the ultimate oil budget costs of each. Oil acquisition budget authority and outlay timing has not been estimated for separate modules, but has been addressed in the evaluation of alternative SPR systems.

Table II.1 Strategic Petroleum Reserve Fill Capability

Base Module and Effects of Alternative Facility Increments

Cumulative MMB, End of Fiscal Year

Increment (Yr of Initial Funding)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Base Module	251	267	343	417	467	563	580	580	580	580
(1) West Hackberry Expansion										
COEXPANSION (FY 82)	-	-	-	-	-11	-25	+18	+30	+30	+30
DEFERRED (FY 84)	-	-	-	-	-	-	1	14	30	30
(2) Big Hill										
100 MMB (FY 82)	-	-	-	-	-	1	25	100	100	100
140 MMB (FY 82)	-	-	-	-	-	-	13	60	140	140
(3) New Solution Mined-Site (FY 83)	-	-	-	-	-	-	-	14	60	120
(4) Cote Blanche (FY 82)	-	-	-	18	40	40	40	40	40	40
(5) Steel Tanks										
40 MMB (FY 82)	-	-	-	-	8	20	32	40	40	40
30 MMB (FY 83)	-	-	-	-	8	20	30	30	30	30

Table II.2 Strategic Petroleum Reserve Facilities Development and Operations Budget
Base Module and Effects of Alternative Facilities Increment
(In Millions of Dollars)

		Prior Years	FY 1982	FY 1983	FY 1984	FY 1985	Fy 1986	FY 1987	FY 1988	Future	Total
Base Module											
	BA	1477	94	161	147	136	108	82	-	-	2205
	BO	1307	154	219	148	120	139	110	8	-	2205
(1) West Hackberry Expansion											
Coexpansion	BA	1	3	34	13	13	15	17	-	-	96
	BO		2	21	22	13	1	24	10	3	96
Deferred	BA				9	35	16	38	42	22	162
	BO				2	25	27	43	39	26	162
(2) Big Hill											
100 MMB	BA	1	81	355	78	64	42	40	51	-	712
	BO		47	175	195	130	58	41	54	12	712
140 MMB	BA	1	81	390	78	64	42	40	50	53	799
	BO		47	184	221	130	58	41	56	62	799
(3) New Solution-Mined Site											
	BA			66	145	397	202	60	66	113	1049
	BO			55	131	355	236	84	65	123	1049
(4) Cote Blanche											
	BA		213	4	7						224
	BO		54	106	61	3					224
(5) Steel Tanks											
40 MMB	BA	6	496		1	2	3	5	5		518
	BO		38	58	105	117	104	60	36		518
30 MMB	BA	6	29	388	1	2	3	4			433
	BO		35	1	104	135	86	72			433

Table II.3. Strategic Petroleum Reserve Oil Costs
(nominal[1] dollars in millions)

	MMB	COSTS
Base Module	580	25,037[2]
West Hackberry		
Coexpansion	30	2,164
Deferred	30	2,169
Big Hill		
100 MMB	100	6,833
140 MMB	140	10,107
New Solution-Mined Site	120	9,223
Cote Blanche	40	2,141
Steel Tanks		
40 MMB	40	2,497
30 MMB	30	1,811

[1] Using price assumptions from the March 10, 1981 President's Budget revisions.

[2] Reflects deduction of the entitlements benefits through July, 1980 (ESA passage), but includes full cost of oil after July, 1980 ($542 million benefit not deducted).

SECTION III

EVALUATION OF ALTERNATIVE INCREMENTS TO THE BASE MODULE

APPROACH

The purpose of this section is to evaluate the alternative facility development increments from the standpoint of both cost and schedule, to identify logical rankings of increments as the basis for identifying SPR configuration/size alternatives in Section IV.

There are a number of different criteria that one could apply to the ranking of alternative increments. Not all criteria result in the same rankings as will be illustrated in this section. Rather than argue for one particular ranking method, we have chosen to employ multiple methods to discover whether there are some logically least and most preferrable alternatives on a weight-of-the-evidence basis.

MINIMIZATION OF THE COST OF FACILITIES

Under this approach, one seeks to minimize the cost of SPR facilities on a per-barrel basis, independent of trends in oil prices and decisions on SPR oil acquisition. This analysis is also independent of schedule except to the degree that the present value of facilities costs is affected by the timing of financial outlays.

Table III.1 presents the per-barrel costs of each facilities increment in budget (escalated) dollars, real 1981 dollars, and the present value in 1981 of the real dollar cost stream, using a 10 percent discount rate.

Table III.1 Per-Barrel Cost Analysis

	INCREMENT	MMB	BUDGET COSTS/BBL			REAL COST/BBL (1981 DOLLARS)			PRESENT VALUE IN 1981 OF REAL COST/BBL		
			FACILITIES	OIL	TOTAL	FACILITIES	OIL	TOTAL	FACILITIES	OIL	TOTAL
	Base Module	580	$ 3.80	$43.17	$46.97	$3.83	$34.54	$38.38	$4.10	$29.04	$33.15
(1)	West Hackberry Expansion										
	Coexpansion	30	$ 3.20	$72.13	$75.33	$2.20	$47.17	$49.37	$1.53	$22.70	$24.23
	Deferred	30	$ 5.40	$72.30	$77.70	$3.07	$47.10	$50.17	$1.83	$23.03	$24.87
(2)	Big Hill										
	100 MMB	100	$ 7.12	$68.33	$75.45	$5.16	$46.07	$51.23	$3.80	$24.24	$28.04
	140 MMB	140	$ 5.71	$72.19	$77.90	$4.04	$47.09	$51.14	$2.96	$23.11	$26.06
(3)	New Solution-Mined Site	120	$ 8.74	$76.86	$85.60	$5.56	$48.36	$53.92	$3.63	$21.77	$25.40
(4)	Cote Blanche	40	$ 5.60	$53.52	$59.12	$4.62	$41.93	$46.55	$3.85	$29.90	$33.75
(5)	Steel Tanks										
	40 MMB (FY 82)	40	$12.95	$62.42	$75.38	$8.98	$44.43	$53.40	$6.35	$26.35	$32.70
	30 MMB (FY 83)	30	$14.43	$60.37	$74.80	$9.90	$43.87	$53.77	$6.93	$27.10	$34.03

The following conclusions can be drawn from Table III.1 in terms of the unit costs of facilities alone.

(1) Whether one is concerned with minimizing budget costs, real dollar costs, or present value of real dollar costs,

  (a) Both West Hackberry expansion subalternatives are the cheapest form of facilities development, and

  (b) Steel tank development costs are the most expensive.

(2) The development of Big Hill is cheaper than the development of a new solution-mined site except that the extended nature of the development of a new site reduces the present value of its cost stream below that of Big Hill 100.

(3) In terms of budget dollars, Cote Blanche is slightly cheaper than both Big Hill alternatives because it involves a faster spendout, but in terms of real-dollar costs, Cote Blanche tends to fall between the Big Hill 140 and Big Hill 100 alternatives.

MINIMIZATION OF THE PER-BARREL COST OF FACILITIES AND OIL

Since oil acquisition will represent over 90 percent of the total costs of the SPR, it is logical to consider both facilities and oil costs in ranking configuration options. Table III.1 illustrates that alternatives with higher facilities costs can have lower overall budget costs, assuming that oil prices increase as projected in the March 10, 1981 President's budget.

(1) Cote Blanche becomes the least expensive alternative in terms of budget costs and real dollar costs on a per-barrel basis, even less costly than the West Hackberry expansion.

(2) In those same terms, steel tanks are less expensive than a new solution-mined site and competitive with Big Hill alternatives, because the oil would be acquired sooner.

(3) The Big Hill 100 MMB subalternative becomes more competitive with the 140 MMB subalternative.

(4) The use of the present value measure of cost substantially changes the rankings from those which result from use of nominal and real dollar measures. The more accelerated alternatives--Cote Blanche and steel tanks--become the most costly. The new solution-mined site, where fill is not complete until 1990, is one of the least expensive alternatives. The reason for these changes is that the oil price projections assume 3 percent annual real growth, while the real discount rate is set at 10 percent, the standard Federal benefit/cost analysis time preference criterion. Therefore, accelerated oil purchases actually increase the present value of oil costs.

It should be noted that per-barrel salvage values have not been netted out of the oil costs for this particular analysis. This does not affect relative rankings because the per-barrel oil salvage value would be the same for all alternatives.

Figure III-1 traces the relative rankings of the alternatives using the different per-barrel cost measures.

MAXIMIZATION OF THE RATIO OF FACILITY FILL CAPABILITY SCHEDULE TO THE PRESENT VALUE OF FACILITIES COSTS

As noted above, the introduction of the present value measure into the evaluation of total program costs tends to penalize the more accelerated alternatives without considering the benefits as well as costs of acceleration. To help correct for this problem, we have developed a ranking measure which is a ratio, expressed as a percentage, of the incremental barrels of storage capacity discounted at various rates to 1981 (present value of benefits) to the present value of facilities costs for each alternative.

The merits of this evaluation measure are that it addresses directly the benefits and costs of the near term investment decision being made on facilities development. It assumes nothing about oil cost trends or oil fill schedule but addresses how, by spending alternative amounts for facilities, one can affect the timing of fill capability.

FIGURE III.1: RANKINGS OF ALTERNATIVES BY PER BARREL COST USING ALTERNATIVE METHODS OF MEASUREMENT (#1ST IS LEAST EXPENSIVE)

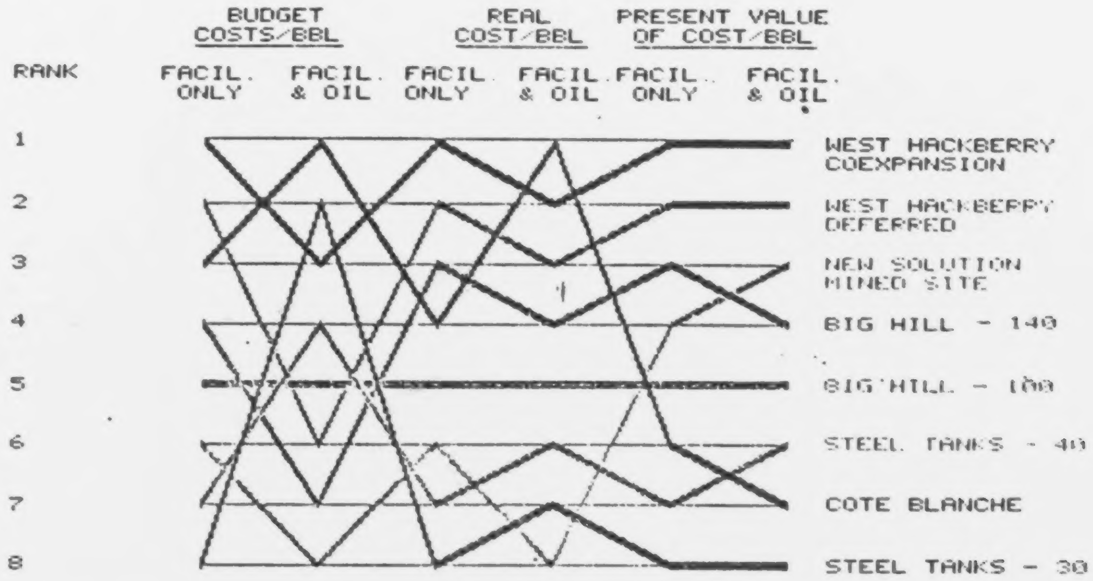


Table III.2 assesses the alternatives in terms of this measure for five different benefit discount rates. Costs remain discounted at 10 percent, irrespective of benefit discount rates. It should be noted that with a 0 percent benefit discount rate, the benefit of each alternative is rated as its total capacity irrespective of schedule. Thus the benefit/cost ratio is actually the inverse of the per-barrel present value cost of facilities, expressed as Table III.1. At higher benefit discount rates, the benefits of each alternative capacity decline below total capacity in accordance with the timing of development.

The following conclusions can be drawn from Table III.2 and Figure III.2, which illustrate these same phenomenon in graphic form.

(1) For all benefit discount rates, the West Hackberry expansion subalternatives remain the most cost-effective.

(2) Steel tanks are the least cost-effective in terms of this measure for all benefit time preferences, though with a strong (20 percent) preference for benefit acceleration, steel tanks become competitive to the development of a new solution-mined site.

(3) Cote Blanche is more cost-effective than either Big Hill 100 or Big Hill 140 with a 10 percent or higher benefit discount.

(4) Big Hill 140 remains relatively more cost effective than Big Hill 100 throughout all benefit discount rates.

MAXIMIZATION OF THE RATIO OF THE END-OF-YEAR FILL CAPABILITY SCHEDULE TO THE PRESENT VALUE OF FACILITIES AND OIL COSTS

We also computed a similar evaluation measure as the one above expressed as a ratio of the total cumulative storage capability discounted at various rates to 1981 to the present value of facilities and oil costs for each

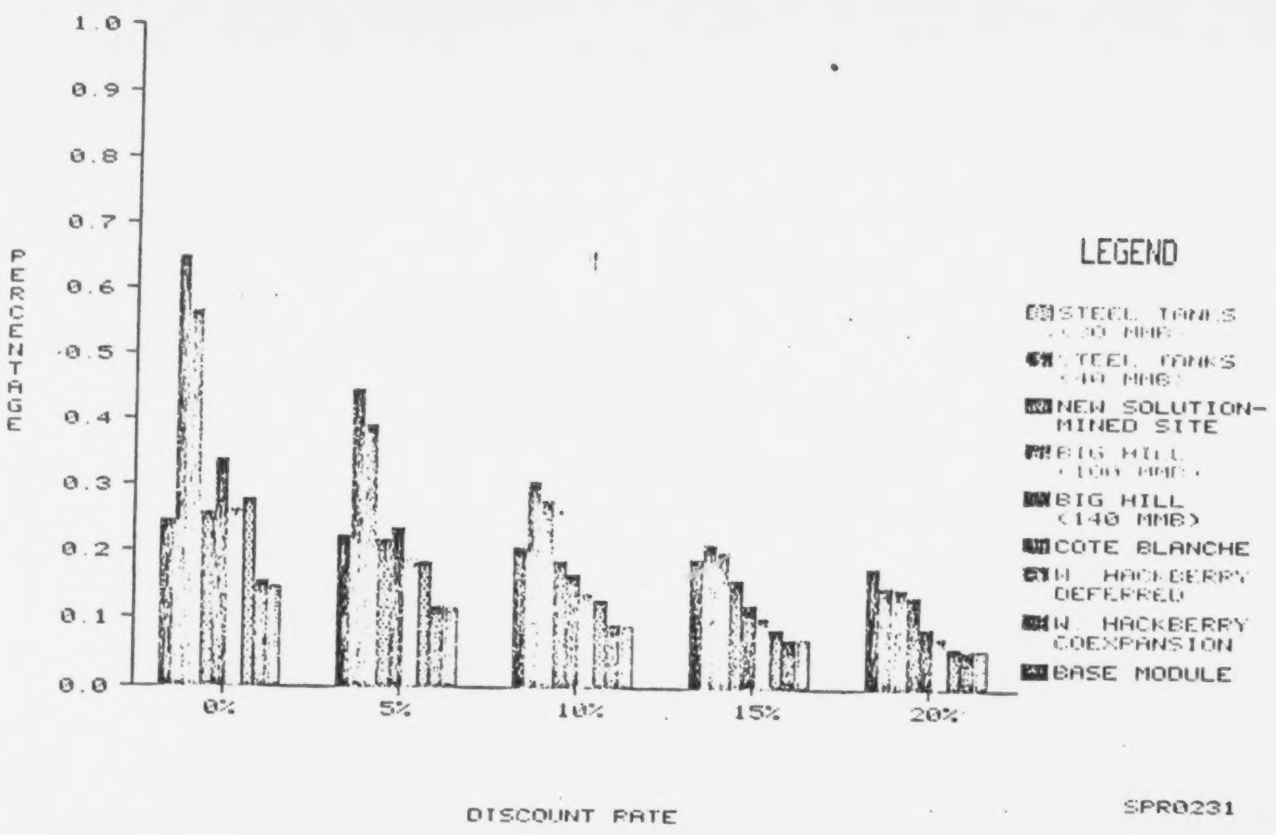
Table III.2. Ration of Time Preference (Discount) Rate on Incremental Capacity to Present Value of Facilities Cost

		Present Value (81) of Facilities Costs (Millions)		Discount Rate			
				0%	5%	10%	15%	20%
	Base Module	$2,378	a[1]	580	527	484.8	450.6	422.6
			b[2]	.244	.221	.204	.189	.178
(1)	West Hackberry Expansion							
	Coexpansion	46	a	30.0	20.6	14.2	9.9	6.8
			b	.647	.444	.306	.212	.147
	Deferred	55	a	30.0	20.8	14.7	10.5	7.7
			b	.566	.392	.277	.199	.145
(2)	Big Hill							
	100 MMB	380	a	100.0	72.0	52.7	39.1	29.4
			b	.261	.188	.137	.102	.076
	140 MMB	414	a	140.0	97.3	68.8	49.4	36.1
			b	.338	.235	.166	.119	.087
(3)	New Solution-Mined Site	436	a	120.0	79.8	54.1	37.4	26.2
			b	.276	.183	.124	.085	.060
(4)	Cote Blanche	154	a	40.0	33.6	28.6	24.4	21.0
			b	.261	.220	.187	.159	.137
(5)	Steel Tanks							
	40 MMB (FY 82)	254	a	40.0	30.6	23.8	18.7	14.9
			b	.153	.117	.091	.071	.057
	30 MMB (FY 83)	208	a	30.0	23.4	18.6	14.9	12.0
			b	.144	.113	.089	.071	.057

[1] Discounted barrels (MMB)

[2] Ratio of discounted barrels to present value of facilities cost

FIGURE III.2: RATIO OF TIME PREFERENCE (DISCOUNT) RATE ON INCREMENTAL CAPACITY TO PRESENT VALUE OF FACILITIES COST.



increment less the present worth of salvage value of the oil. Salvage values were computed based on full project life and half-project life.[1]

The merit of this measure is that it represents the "benefit" in each year as the cumulative fill (versus the incremental) which is available at the start of that year to offset economic losses due to an oil supply cutoff. Thus, it has the attribute of being a reasonable proxy of economic benefit. On the cost side it considers total systems costs less the value of the oil (recoverable costs) at the end of project life and thus it is a closer representation of total life cycle costs.

Tables III.3 and III.4 and Figures III.3 and III.4 present the above ratio for each incremental alternative examined for five different benefit discount rates for full project life and half-project life, respectively. As with the previous ratio, costs remain discounted at 10 percent irrespective of benefit discount rates.

As expected, ratios computed on the basis of half-project life indicated more preference for faster alternatives whereas ratios computed at full project life require more discounting of benefits to justify higher cost systems.

On the basis of the values of this evaluation measure, the following conclusions can be made.

(1) West Hackberry coexpansion is preferred at lower values of benefit discounting, whereas Cote Blanche is preferred at higher value of discounting.

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[1] Project life is defined as the "backstop" year. The backstop year is that year when the real price of oil is such that alternative fuels replace petroleum. In this analysis the backstop year is 2004. (For further discussion see Section V.)

Table III.3. Ratio of Time Preference (Discount) Rate on Cumulative Capacity for Full Project Life to Present Value of Facilities and Oil Cost Less Salvage Value

	Present Value (81) of Real Facilities and Oil Costs Less Salvage Cost (Millions)		Discount Rate				
			0%	5%	10%	15%	20%
Base Module	13,823	a[1]	12,150.0	6763.6	4199.9	2848.5	2069.1
		b[2]	.879	.489	.504	.206	.150
(1) West Hackberry							
Coexpansion	477	a	462.0	216.6	108.7	57.6	31.8
		b	.986	.454	.228	.120	.066
Deferred	495	a	465.0	220.9	113.5	62.3	36.2
		b	.938	.445	.229	.125	.073
(2) Big Hill							
100 MMB	1975	a	1626.0	788.7	414.9	233.7	139.3
		b	.823	.399	.210	.118	.070
140 MMB	2483	b	2173.0	1033.4	531.4	2921	169.8
		b	.875	.416	.214	.117	.068
(3) New Solution-Mined Site	2134	a	1754.0	813.9	406.9	216.9	122.1
		b	.822	.381	.191	.102	.057
(4) Cote Blanche	1110	a	778.0	412.5	240.8	152.0	102.1
		b	.700	.372	.217	.137	.092
(5) Steel Tanks							
40 MMB (FY 82)	981	a	700.0	352.0	193.3	114.2	71.6
		b	.713	.358	.196	.116	.072
30 MMB (FY 83)	770	a	538.0	273.6	152.1	91.1	57.9
		b	.698	.355	.197	.118	.075

[1] Discounted Barrel years

[2] Ratio of discounted barrel-years to present value of costs less salvage

Table III.4. Ratio of Time Preference (Discount) Rate on Cumulative Capacity for Half-Project Life to Present Value of Facilities and Oil Cost Less Salvage Value

	Present Value (81) of Real Facilities and Oil Costs Less Salvage Cost (Millions)		Discount Rate				
			0%	5%	10%	15%	20%
Base Module	8,028	a^1	5153.0	3728.2	2790.5	2152.8	1705.9
		b^2	.679	.464	.348	.268	.212
(1) West Hackberry							
Coexpansion	177	a^1	102.0	61.1	37.1	22.7	13.9
		b^2	.575	.345	.209	.128	.078
Deferred	196	a^1	105.0	65.5	41.8	27.3	18.2
		b^2	.536	.334	.213	.139	.093
(2) Big Hill							
100 MMB	975	a^1	426.0	270.5	176.1	117.2	79.6
		b^2	.436	.277	.180	.120	.081
140 MMB	1084	a^1	493.0	307.9	197.1	129.0	86.2
		b^2	.454	.283	.181	.118	.079
(3) New Solution-Mined Site	886	a^1	314.0	192.0	120.3	77.1	50.4
		b^2	.354	.217	.136	.087	.057
(4) Cote Blanche	674	a^1	298.0	205.2	145.3	105.4	78.2
		b^2	.442	.304	.216	.156	.116
(5) Steel Tanks							
40 MMB (FY 82)	582	a^1	220.0	144.7	97.7	67.6	47.7
		b^2	.378	.248	.168	.116	.082
30 MMB (FY 83)	471	b^2	178.0	118.1	80.5	56.1	40.0
		b^2	.378	.251	.170	.119	.084

[1] Discounted barrel years

[2] Ratio of discount barrel-years to present value of costs less salvage

FIGURE III.3: RATIO OF TIME PREFERENCE (DISCOUNT) RATE ON CUMULATIVE CHARGES FOR FULL PROJECT LIFE TO PRESENT VALUE OF FACILITIES AND OIL LESS SALVAGE VALUE.

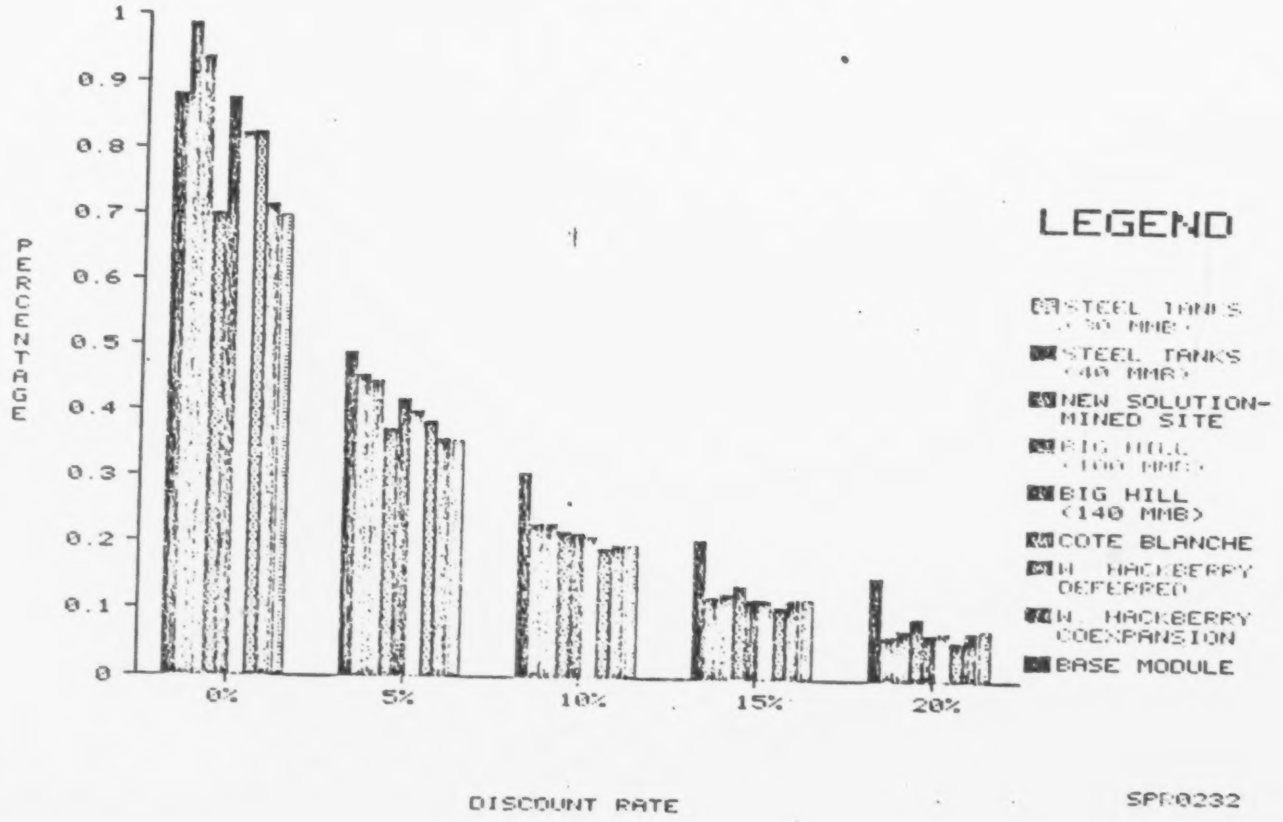
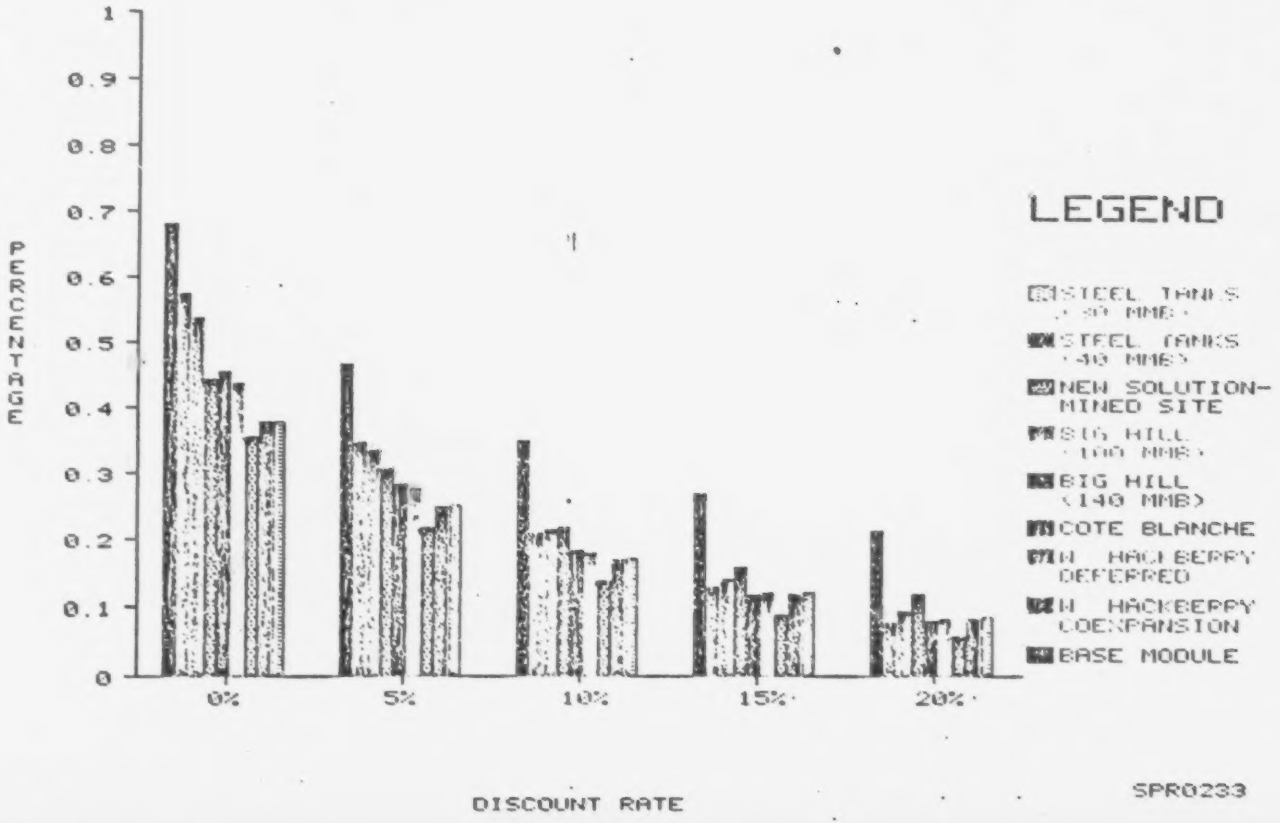


FIGURE III.4: RATIO OF TIME PREFERENCE (DISCOUNT) RATE ON CUMULATIVE CAPACITY FOR HALF-PROJECT LIFE TO PRESENT VALUE OF FACILITIES AND OIL LESS SALVAGE VALUE



(2) Steel tanks are less cost-effective than any other alternative except for high rates of discounting benefits if the entire project life is considered. They are only marginally preferred in the near term over a new 120 MMB salt dome site.

(3) Cote Blanche is more cost-effective than both versions of Big Hill except when benefits are discounted at a low rate over the full project life.

(4) Big Hill 140 is preferred over Big Hill 100 except for high discounting of benefits.

SECTION IV

DESCRIPTION OF SPR SYSTEM ALTERNATIVES

Based on the rank evaluation in Section III, we have drawn the following conclusions:

(1) That the composition of the 750 MMB program in the FY 1982 budget --the Base Module (580 MMB) plus the 30 MMB coexpansion of West Hackberry plus the development of 140 MMB in capacity at Big Hill --is the preferred composition if SPR development is to terminate at 750 MMB. The West Hackberry and Big Hill increments rank consistently high using a wide range of alternative criteria. Specifically, these increments rank above all others except Cote Blanche for the following criteria.

- Minimization of the unit cost of facilities in nominal dollars, real dollars, and the present value of real dollars.
- Minimization of real dollar program (oil plus facilities) costs per barrel.
- Ratio of discounted facility capacity increments to present value of facilities costs, for all discount rates.
- Ratios of discounted barrel-years of protection to total program investment value (present value of facilities and oil costs net of salvage value) up to and including benefit discount rates of 10 percent per year.

(2) Under most circumstances, Cote Blanche is the most attractive competition to the current 750 MMB program composition. It should have priority in any decision to go beyond 750 MMB total system size. In some measures, it is preferred to some portions of the current configuration but such preference is sensitive to

estimates of the ultimate storage capacity of the Cote Blanche mine. For example, on Tables III.2 and III.3, Cote Blanche appears preferable to Big Hill 140 at a 10 percent benefit discount ratio, but a 10 percent reduction in the 40 MMB estimated Cote Blanche capacity would make the preference for these two projects equivalent. Yet, no such 10 percent reduction in capacity would render Cote Blanche less attractive than steel tanks.

(3) A new solution-mined site, while less attractive than Cote Blanche, could be more or less attractive than steel tanks, depending on one's time preference (discount) rate and on project duration. Solution mining is slower but cheaper and could be preferable if one's concern is with facilities costs and not with schedule. A continuation of the program to the end of this century makes a new solution-mined site attractive relative to steel tanks, but if one's only concern is with the current decade, steel tanks make more sense.

Based on these general findings, we have developed the following SPR System alternatives for consideration:

SYSTEM #1 750 MMB SYSTEM (FY 1983)

This system consists of the 580 MMB Base Module, the West Hackberry coexpansion and the Big Hill site developed to 140 MMB. The configuration is thus the same as the FY 1982 budget plan, but the schedule is different because of the acceleration of Bryan Mound leaching. Table IV.1 presents the buildup of the oil fill schedule for this system.

Assuming that the SPR is filled to capacity (267 MMB) at the end of FY 1982, the following (refer to Table IV.2) are the fill levels for future years expressed as total annual fill and average daily fill rates.

Table IV.1. 750 MMB System (1983)
Oil Fill Capability
(Cumulative MMB, end of fiscal year)

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Base Module	251	267	343	417	467	563	580	580	580
West Hackberry Coexpansion	0	0	0	0	-11	-25	+18	30	30
Big Hill 140	0	0	0	0	0	0	13	60	140
750 MMB System	251	267	343	417	456	538	611	670	750
FY 1982 Budget	248	261	331	398	409	481	605	687	750
Change	+3	+6	+12	+19	+47	+57	+6	-17	0

Table IV.2. 750 System (1983)
Annual Oil Fill Levels

Fiscal Year	Annual Total (MMB)	Average Daily Rate MBD
1983	76	208
1984	74	203
1985	39	107
1986	82	225
1987	73	200
1988	59	162
1989	80	219
Average	69	189

In no year would fill equal or even approach 300 MBD unless a substantial underfill had occurred in the prior year. If in one of the seven fiscal years, fill were constrained to about 100 MBD (37 MMB/year), the Energy Security Act minimum, then an average rate of fill of 200 MBD would be achieved in the other six fiscal years.

SYSTEM #2. 790 MMB SYSTEM

This system consists of the 750 MMB System (System #1) plus the addition of the Cote Blanche site at 40 MMB. Table IV.3 presents the oil fill capability for this system.

Table IV.3. 790 MMB System
Oil Fill Capability
(Cumulative MMB, End of Fiscal Year)

	1981	1982	1983	1984	1985	1986	1987	1988	1989
750 MMB System (1983)	251	267	343	417	456	538	611	670	750
Cote Blanche	0	0	0	18	40	40	40	40	40
790 MMB System	251	267	343	435	496	578	651	710	790
Annual Fill (MMB)		--	76	92	61	82	73	59	80
Average Daily Fill (MBD)			208	252	167	225	200	162	219

The average annual fill for the FY 1983- 1989 period increases to almost 75 MMB/year (205 MBD) for the 790 MMB system in comparison to the 750 MMB alternative.

Two years would be filled at less than 200 MMD (1986 and 1988) unless a prior year had been underfilled. If oil fill were constrained to 100 MBD in one of the years, an average fill rate of 222 MBD could be achieved in the remaining six years.

As noted in Section II, the Cote Blanche increment assumes FY 1982 funding of over $200 million from a budget amendment. If this funding were obtained from an FY 1982 supplemental, available in the Spring of 1982, then a 6-month delay would ensue, slipping the entire 40 MMB in fill into FY 1985. A full year delay in funding until FY 1983 would result in a full year delay in the fill capability schedule.*

SYSTEM #3. 890 MMB SYSTEM

This system consists of the 790 MMB system described above plus a further 100 MMB in steel tank development: one 40 MMB site funded in FY 1982 plus two further sites, each 30 MMB, funded in FY 1983. Table IV.4 presents the fill capability for this system.

Table IV.4. 890 MMB System

Oil Fill Capability

(Cumulative MMB, End of Fiscal Year)

	1981	1982	1983	1984	1985	1986	1987	1988	1989
790 MMB System	251	267	343	435	496	578	651	710	790
40 MMB Steel Tanks	0	0	0	0	8	20	32	40	40
60 MMB Steel Tanks	0	0	0	0	16	40	60	60	60
Total, 890 MMB System	251	267	343	435	520	638	743	810	890
Annual Fill (MMB)			76	92	85	118	105	67	80
Fill Rate (MBD)			208	252	233	323	288	184	219

The average fill rate for the FY 1983 - 1980 period would be 244 MBD, increasing to 268 MBD for six years if fill were constrained to 100 MBD for one year.

SYSTEM #4. 1000 MMB SYSTEM - MIXED

This system consists of the 890 MMB System (#3) which includes 100 MMB in steel tanks, plus the addition of a 120 MMB solution-mined site filled to 110 MMB. Table IV.5 outlines the capacity schedule associated with this option.

Table IV.5. 1000 MMB System - Mixed
Oil Fill Capability
(Cululative MMB, End of Fiscal Year)

	1982	1983	1984	1985	1986	1987	1988	1989	
890 MMB System	267	343	435	520	638	743	810	890	890
One Solution-mined Site	---	---	---	---	---	---	14	60	110
1000 MMB System-Mixed	267	343	435	520	638	743	824	950	1000
Annual Fill (MMB)		76	92	85	118	105	81	126	50
Fill Rate (MMB)		208	252	233	323	288	222	345	137

In comparison to exclusive reliance on steel tanks for the 790 - 1000 MMB increment (System #5), this system defers the high "spike" year of annual fill from 1987 to 1989 and solves the qualitative problem of the marginal difficulties in locating additional steel tank sites.

SYSTEM #5. 1000 MMB SYSTEM -STEEL TANKS ONLY

This system would emphasize schedule over cost, entailing the 890 MMB system described above plus a further 110 MMB in steel tanks, funded in FY 1984. Thus the overall system would include a total of 210 MMB in steel tanks. Table IV.6 presents the fill capability for this system.

Table IV.6. 1000 MMB System - Steel Tanks Only

Oil Fill Capability

(Cumulative MMB, end of fiscal year)

	1981	1982	1983	1984	1985	1986	1987	1988	1989
890 MMB System	251	267	343	435	520	638	743	810	890
110 MMB Steel Tanks	0	0	0	0	0	24	60	94	110
1000 MMB System-Steel Tanks Only	251	267	343	435	520	662	803	904	1000
Annual Fill (MMB)			76	92	85	142	141	101	96
Avg. Daily Fill (MBD)			208	252	233	389	387	277	263

This system permits average annual fill of 105 MMB (287 MBD) over the 1983 - 1989 period, or 116 MMB (318 MBD) for six years if fill is constrained to 100 MBD in one year. With a projected oil price of nearly $65/bbl in 1987, annual oil costs would peak in that year at $9.5 billion, considerably more than the current budget level.

One factor which may not be adequately treated in this system proposal is the potential problem associated with identifying six sites for very large steel tank development. While there is no current empirical basis for analyzing this phenomenon, one could project that from the standpoint of both economics and environmental and community aspects, each successive steel tank site will be marginally more difficult to identify and secure for SPR use. Also, each successive steel tank development project would have marginally greater impact on the capacity utilization in the steel tank fabrication industry. While we understand that unused productive capacity exists, it is reasonable to expect that the development of 210 MMB in steel tanks would have disproportionate effects on the industry in relation to a 100 MMB steel tank system.

One other factor not adequately treated here is the environmental problems of steel tanks which may require the government to acquire "offsets" (reduction in pollution from other sources) which may add costs and delay completion of the tank farms.

Table IV.7 summarizes the oil fill capability schedules for all alternatives and Table IV.8 summarizes annual fill rates for all systems alternatives.

In considering alternative methods of financing the SPR, the Congress is contemplating setting an annual average daily fill target of 300 MBD (S.918, HR 3808) or 230 MBD (S.1343). These fill levels translate into the cumulative fill requirements after 1982 noted on the bottom of Table IV.8, assuming the SPR is filled to capacity in these years.

None of the systems can meet either of these requirements in FY 1983 and there is no known construction method which could solve this shortfall. The 790 MMB System (B) could meet the 230 MBD criterion during the 1984-1986 period and, through the use of at least 100 MMB in steel tanks, this criterion could be met for all years after 1983.

The 300 MBD criterion is essentially unachievable by all systems alternatives.

Program Costs

Section III illustrated the variety of methods by which program cost information can be portrayed. The appendix contains the detailed information on the costs for each increment and each total system. Table IV.8 contains a summary of SPR system alternatives and Table IV.9 presents a summary of the oil and facilities costs for each system alternative, expressed in Table IV.10 on a per-barrel basis. Table IV.11 presents the near-term (FY 1982-1984) budget authority and outlay requirements for each system.

Table IV.7. Summary of SPR System Alternatives
Oil Fill Capability Schedules

(Cumulative MMB, End of Fiscal Year)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
#1. 750 MMB(1983)	251	267	343	417	456	538	611	670	750	750
#2. 790 MMB	251	267	343	435	496	578	651	710	790	790
#3. 890 MMB	251	267	343	435	520	638	743	810	890	890
#4. 1000 MMB-Mixed	251	267	343	435	520	638	743	824	950	1000
#5. 1000 MMB-Steel tanks	251	267	343	435	520	662	803	904	1000	1000
230 MBD			351	435	519	603	687	750		
300 MBD			377	486	596	705	750			

Table IV.8. Summary of SPR System Alternatives
Annual and Average Daily Oil Fill Rates

(Annual Fill in MMB, Average Daily Fill in MBD)

Fiscal Year

		1983	1984	1985	1986	1987	1988	1989	1990
#1. 750 MMB (1983)	MMB/YR	76	74	39	82	73	59	80	0
	MBD	208	203	107	225	200	162	219	0
#2. 790 MMB	MMB/YR	76	92	61	82	73	59	80	0
	MBD	208	252	167	225	200	162	219	0
#3. 890 MMB	MMB/YR	76	92	85	118	105	67	80	0
	MBD	208	252	233	323	288	184	219	0
#4. 1000 MMB-Mixed	MMB/YR	76	92	85	118	105	81	126	50
	MBD	208	252	233	323	288	222	345	137
#5. 1000 MMB Steel Tanks	MMB/YR	76	92	85	142	141	101	96	0
	MBD	208	252	233	389	387	277	263	0

Table IV.9. Funding Requirements for Alternative Systems
(In Millions)

		NOMINAL DOLLARS			REAL 1981 DOLLARS		
SYSTEM	MMB	FACILITIES	OIL	TOTAL	FACILITIES	OIL	TOTAL
#1	750	$ 3,100	$37,406	$40,506	$2,853	$28,041	$30,894
#2	790	$ 3,324	$39,547	$42,871	$3,038	$29,718	$32,756
#3	890	$ 4,708	$45,666	$50,374	$3,991	$34,127	$38,118
#4	1000	$ 5,757	$54,089	$59,846	$4,658	$39,438	$44,096
#5	1000	$ 6,177	$52,995	$59,172	$4,913	$39,142	$44,055

Table IV.10. Per-Barrel Costs for Alternative Systems

	NOMINAL DOLLARS			REAL 1981 DOLLARS		
SYSTEM	FACILITIES	OIL	TOTAL	FACILITIES	OIL	TOTAL
#1	$4.13	$49.87	$54.00	$3.80	$37.39	$41.19
#2	$4.21	$50.06	$54.27	$3.84	$37.62	$41.46
#3	$5.29	$51.31	$56.60	$4.48	$38.34	$42.83
#4	$5.76	$54.10	$59.86	$4.66	$39.44	$44.10
#5	$6.18	$53.00	$59.17	$4.91	$39.14	$44.06

Table IV.11. Near-Term Budget Requirements for Alternative Systems
(In Millions)

SYSTEM[1]	FY 1982 BA	FY 1982 BO	FY 1983 BA	FY 1983 BO	FY 1984 BA	FY 1984 BO
#1	$3,883	$3,625	$4,933	$3,845	$3,183	$4,429
#2	$4,097	$3,680	$4,939	$3,952	$5,332	$5,105
#3	$4,654	$3,791	$5,716	$4,013	$6,001	$5,418
#4	$4,658	$3,795	$5,785	$4,071	$6,149	$5,552
#5	$4,676	$3,795	$5,834	$4,127	$7.298	$5,538

[1] Includes planning and program direction costs.

SECTION V

ECONOMIC COST ANALYSIS OF ALTERNATIVE SPR SYSTEMS

This section presents the results of a benefit-cost analysis of the economic value of several alternative configurations for the Strategic Petroleum Reserve (SPR). These SPR alternatives--defined and discussed in the previous chapter--include five systems, 750 MMB, 790 MMB, 890 MMB, and two 1,000 MMB sizes.

The economic concept employed in this analysis to develop a benefit-cost measure is based on the idea of social surplus loss. Here, a given SPR system is evaluated with respect to its ability to reduce the social surplus loss associated with a disruption to the nation's supply of oil. At its simplist, the social surplus concept evaluates the increased cost of oil faced by consumers multiplied by the quantity consumed. It negatively affects consumers of oil who continue to buy at higher prices; and it also negatively affects those who are forced to forego consumption. On the other hand, it positively affects the domestic producers of oil who obtain more revenue due to the price increase stemming from the supply shortfall.[1]

The particular methodological formulation of the social surplus loss approach followed here is based on the utilization of a multi-period stochastic dynamic programming model produced for the Office of Policy and Analysis of this agency by Dr. Tom Teisberg in 1977.

Although the Teisberg model does indeed offer an objective and fairly realistic method of approaching the evaluation of a given SPR alternative system, this model--like most such models--is intrinsically dependent on the exogeneous selection of a specific set of economic assumptions. In sum, these assumptions relate to the future character of the world oil market and also to the likelihood of a world oil shortfall. Changing these assumptions necessarily and directly affects the output of the Teisberg model.

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[1] There are, in fact, other types of analyses which might be carried out to estimate the economic benefit of a given SPR system. One such, based on the concept of gross national product loss averted, attempts to calculate some roughly analogous figure that is at once less precise and more comprehensive in its formulation.

Aside from this dependency on important assumptions, the Teisberg model (in the present formulation used here) tends to be somewhat insensitive to small differences in the fill capacity schedule of alternative SPR systems. Data input procedures call for rounding the SPR capacity to the nearest 50 MMB. The practical effect is to sometimes understate and other times overstate the given SPR system's benefit by magnitudes of up to 50 million barrels. Table V.1 shows the comparison of actual fill capacity schedules for each of the five SPR options analyzed in this report to indexes of fill capacity schedules used by the model, illustrating the effects of this procedure.

The basic element of the Teisberg model is an oil market "insecurity cost function." This function depends primarily on the nature of the world oil market that would be faced by a given SPR program over its operational life. In this analysis, world oil markets are represented by three characteristics "states":

(1) a "slack" market, wherein SPR oil purchases would take place without any impact on the world oil market in general;

(2) a "tight" market, wherein SPR oil acquisitions would raise the world oil price at a rate of $1.50/bbl. for each 500 thousand barrels per day. This would have the effect of increasing the oil price about 60 cents per barrel at current SPR oil fill levels of 200 thousand barrels per day; and

(3) an oil market supply disruption "state" that assumes an OPEC delivery cutback amounting to about 12 million barrels per day, or 40 percent of OPEC's current total output.

Markov chain probability transition matrices are used to manipulate statistical assumptions about the likelihood of encountering each of these market states each year. This analysis evaluates the significance of a wide range of assumptions regarding encountering such an oil supply disruption as described in (3), ranging from 0 percent yearly to 20 percent yearly.

It should be remembered, however, that these seemingly modest assumptions about likelihood of yearly disruption translate into far higher values when considered in terms of the probability of experiencing at least one such disruption over the lifespan of the project. For example, a 5 percent likelihood of yearly disruption implies a 71 percent likelihood of at least one such disruption over a 24-year project lifespan.

OTHER ESSENTIAL ASSUMPTIONS

Several other important assumptions are made in the implementation of the Teisberg model. The world oil price path is assumed to begin at $34 per barrel in 1981, rising by 3 percent per year until it reaches a "backstop" price of $75 per barrel in year 2004. In that year, imported oil is assumed to be no longer essential for the nation's economic well-being, and therefore the SPR oil can be sold off and the project discontinued.

The primary costs of the SPR are the costs of purchasing or acquiring the oil, plus the holding costs. Of course,the cost of acquiring the oil is the market price at the time the oil is purchased plus the transportation cost when it is delivered. The holding cost, on the other hand, has two components;

(1) the cost of building and maintaining the storage facilities;

(2) the opportunity or capital cost of holding onto a valuable commodity. A discount rate of 10 percent is used to represent the return that could be received from the next most comparable investment.

OPTIMIZATION RESULTS

Table V.2 presents the results of the Teisberg model evaluation of the five alternative hypothetical systems considered in this analysis.

Table V.1. Illustration of the Translation Procedure Employed to Introduce Values for the Fill Capacity Schedule of Each Alternative SPR Hypothetical Option to the Teisberg Model

	SPR Options: Fill Capacity Schedule (MMB)				
Year	750	790	890	1,000	1,000
1981	251	251	251	251	251
1982	267	267	267	267	267
1983	343	343	343	343	343
1984	417	435	435	435	435
1985	456	496	520	496	523
1986	538	578	638	578	668
1987	610	650	742	650	808
1988	670	710	810	738	898
1989	750	790	890	910	1,000
1990	750	790	890	1,000	1,000
	SPR Options: Fill Capacity Model Schedule Translation (Index)				
1981	6	6	6	6	6
1982	6	6	6	6	6
1983	8	8	8	8	8
1984	9	10	10	10	10
1985	10	11	11	11	11
1986	12	13	14	13	14
1987	13	14	16	14	17
1988	14	15	17	16	19
1989	16	17	19	19	21
1990	16	17	19	21	21

As is indicated, the net economic benefit (expressed as consumer surplus loss avoided) of all of the five alternatives is negative in the instance where the likelihood of shortfall is zero. However, it rises quickly into a positive value for each of the alternatives at the 1 percent mark for probability of shortfall escalating upward to over $323 billion under the assumption of a 20 percent annual probability of shortfall in the instance of the second billion barrel SPR alternative. In each case, there is a positive correlation between likelihood of shortfall and consumer surplus loss avoided.

Table V.3 presents these same results in terms of an ordinal ranking. It suggests a systematic shift of optimality from the smaller to the larger of the alternatives as the probability of a shortfall is assumed to advance. In the instance of a very small likelihood of shortfall, the 750 MMB system proves out to be the optimal system. However, by the time that the probability is scaled upwards to 4 percent, the 750 MMB system is shown to be relegated to last place in terms of optimality.

Table V.2. Results of Teisberg Model Analysis:
Net Expected Economic Benefits[2] ($billion)

Assumed Probability of Shortfall		SYSTEM				
	Project	(1)	(2)	(3)	(4)	(5)
Yearly	Life[1]	750	790	890	1,000	1,000
		(tight market condition)				
0.0	0.0	-6.7	-6.8	-7.3	-7.7	-8.0
1.0	.21	5.53	5.38	4.87	4.51	4.15
2.0	.38	20.72	20.68	20.17	19.81	19.45
3.0	.48	40.79	41.24	41.31	41.01	40.72
4.0	.62	60.34	61.43	62.15	63.04	62.82
5.0	.71	79.18	80.85	82.88	83.72	83.73
10.0	.92	162.92	166.89	172.26	175.20	175.75
15.0	.98	230.12	241.85	242.87	246.77	247.60
20.0	.99+	283.16	298.67	297.22	301.72	302.65
		(slack market condition)				
5.0	.71	90.18	92.74	96.22	98.42	98.68
10.0	.92	176.81	181.74	188.68	192.83	193.63
15.0	.98	246.49	252.80	261.27	266.29	267.45
20.0	.99+	301.03	307.98	316.80	322.21	323.37

[1] Expresses the statistical chance of encountering at least one such oil supply shortfall over the project life of 24 years running from 1981 to 2004 inclusive.

[2] Represents expected consumer surplus loss avoided based on SPR oil transactions less costs of SPR storage facilities.

Table V.3. Rank Ordering of the Results of the Teisberg Model Analysis According to Size of Consumer Surplus Loss Avoided

Assumed Probability of Shortfall		SYSTEM				
Yearly	Project Life[1]	(1) 750	(2) 790	(3) 890	(4) 1,000	(5) 1,000
				(tight market condition)		
0.0	0.0	N/A	N/A	N/A	N/A	N/A
1.0	.21	1	2	3	4	5
2.0	.38	1	2	3	4	5
3.0	.48	4	2	1	3	5
4.0	.62	5	4	3	1	2
5.0	.71	5	4	3	2	1
10.0	.92	5	4	3	2	1
15.0	.98	5	4	3	2	1
20.0	.99+	5	4	3	2	1
				(slack market condition)		
5.0	.71	5	4	3	2	1
10.0	.92	5	4	3	2	1
15.0	.98	5	4	3	2	1
20.0	.99+	5	4	3	2	1

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[1] Expresses the statistical chance of encountering at least one such oil supply shortfall over the project life of 24 years running from 1981 to 2004 inclusive.

APPENDIX A: DETAILED DATA

BASE MODULE
ALTERNATIVE INCREMENTS TO BASE MODULE
BASELINE SYSTEM
ALTERNATIVE SYSTEMS

APPENDIX A: DETAILED DATA

BASE MODULE ALTERNATIVE INCREMENTS TO
BASE MODULE BASELINE SYSTEM ALTERNATIVE
SYSTEMS

This appendix presents costs, fill capability and fill data for the Base Module and alternative increments to that module for achieving a 750 MMB System (Tables A-1 through A-9). Additionally, it presents fully detailed budget requirements for achieving the 750 MMB Baseline System and alternative larger systems of 790 MMB, 890 MMB and 1,000 MMB, respectively (Tables A-11 through A-14).

The individual tables are identified as follows:

A-1 PROJECT DATA SHEET - BASE MODULE
A-2 PROJECT DATA SHEET - WEST HACKBERRY 30 MMB COEXPANSION
A-3 PROJECT DATA SHEET - WEST HACKBERRY 30 MMB DEFERRED
A-4 PROJECT DATA SHEET - BIG HILL 100 MMB
A-5 PROJECT DATA SHEET - BIG HILL 140 MMB
A-6 PROJECT DATA SHEET - NEW 120 MMB SOLUTION-MINED SITE
A-7 PROJECT DATA SHEET - COTE BLANCHE 40 MMB
A-8 PROJECT DATA SHEET - STEEL TANKS 40 MMB
A-9 PROJECT DATA SHEET - STEEL TANKS 30 MMB
A-10 BUDGET AUTHORITY REQUIREMENTS - 750 MMB BASELINE SYSTEM
A-11 BUDGET AUTHORITY REQUIREMENTS - 790 MMB UNDERGROUND SYSTEM
A-12 BUDGET AUTHORITY REQUIREMENTS - 890 MMB MIXED SYSTEM
A-13 BUDGET AUTHORITY REQUIREMENTS - 1,000 MMB MIXED SYSTEM
A-14 BUDGET AUTHORITY REQUIREMENTS - 1,000 MMB STEEL TANKS SYSTEM

TABLE A-1

PROJECT DATA SHEET

580 MMB BASE MODULE

		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	TOTAL
Facilities (in Millions of $)															
Phase I															
Nominal (Budget) Dollars															
	BA	300	382	174	-	-	-								856
	BO	51	318	374	29	59	25								856
Phase II															
Nominal Dollars															
	BA		65	422	-	40	34	49	63	21	8	-			702
	BO		3	80	173	160	80	92	52	40	17	5			702
Phase III - Bryan Mound															
Nominal Dollars															
	BA					1	19	25	6	37	19	10	-	-	117
	BO					1	12	30	6	15	35	18	-	-	117
Non Phase Specific[1]															
Nominal Dollars															
	BA		17	36	-	40	41	87	78	78	81	72	-		530
	BO			6	19	34	37	97	90	65	87	87	8		530
Total Facilities															
Nominal Dollars															
	BA	300	464	632	-	81	94	161	147	136	108	82	-		2205
	BO	51	321	460	221	254	154	219	148	120	139	110	8		2205
Real (1981) Dollars					1302[2]	254	140	181	111	81	86	62	4		2226
PV in 1981 of Real Dollars					1619[2]	254	127	150	83	55	53	35	2		2378
Cumulative Fill Capability (MMB)					250[2]	251	267	343	417	467	563	580	580	580	
Annual Fill (MMB)					93[2]	104	70	76	74	50	96	17			580
Oil Cost (in Millions of $)															
Nominal Dollars					1350[2]	3925	2960	3551	3782	2746	5662	1061			25037
Real Dollars					1653[2]	3925	2691	2935	2841	1875	3515	598			20033
PV in 1981 of Real Dollars					2117[2]	3925	2224	2426	2134	1280	2182	337			16847

[1] Includes withdrawal Engineering, Sustaining Operations and Phase III A/E Contract

[2] Cumulative total through FY 1980

TABLE A-2
PROJECT DATA SHEET
WEST HACKBERRY 30 MMB COEXPANSION

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
Facilities (in Millions of $)											
Nominal (Budget) Dollars											
BA	1	3	34	13	13	15	17				96
BO		2	21	22	13	1	24	10	2	1	96
Real (1981) Dollars		2	17	17	9	1	14	5	1	-	66
PV in 1981 of Real Dollars		2	14	13	6	-	8	3	-	-	46
Cumulative Fill Capability (MMB)					-11	-25	+18	+30	+30	+30	
Annual Fill (MMB)					-11	-14	+43	+12			30
Oil Price:											
Nominal Dollars					55.51	60.02	64.65	69.61			
Real Dollars					42.48	43.75	45.06	46.42			
Oil Cost (in Millions of $)											
Nominal Dollars					-611	-840	2780	835			2164
Real Dollars					-467	-613	1938	557			1415
PV in 1981 of Real Dollars					-319	-380	1094	286			681

TABLE A-3

PROJECT DATA SHEET

WEST HACKBERRY - 30 MMB DEFERRED

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
Facilities (in Millions of $)											
Nominal (Budget) Dollars											
BA				9	35	16	38	42	22	-	162
BO				2	25	27	43	39	21	5	162
Real (1981) Dollars				2	17	17	24	20	10	2	92
PV in 1981 of Real Dollars				2	12	11	14	10	5	1	55
Cumulative Fill Capability (MMB)							1	14	30	30	
Annual Fill (MMB)							1	13	16		30
Oil Price:											
Nominal Dollars							64.65	69.61	74.94		
Real Dollars							45.06	46.42	47.81		
Oil Cost (in Millions of $)											
Nominal Dollars							65	905	1199		2169
Real Dollars							45	603	765		1413
PV in 1981 of Real Dollars							25	309	357		691

TABLE A-4
PROJECT DATA SHEET
BIG HILL : 100 MMB

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
Facilities (in Millions of $)												
Nominal (Budget) Dollars												
BA	1	81	355	78	64	42	40	51				712
BO		47	175	195	130	58	41	54	7	5	-	712
Real (1981) Dollars		43	145	147	89	36	23	28	3	2	-	516
PV in 1981 of Real Dollars		39	120	110	61	22	13	14	1	-	-	380
Cumulative Fill Capability (MMB)						1	25	100	100	100	100	
Annual Fill (MMB)						1	24	75				100
Oil Price:												
Nominal Dollars						60.22	64.65	69.61				
Real Dollars						43.75	45.06	46.42				
Oil Cost (in Millions of $)												
Nominal Dollars						60	1552	5221				6833
Real Dollars						44	1081	3482				4607
PV in 1981 of Real Dollars						27	610	1787				2424

TABLE A-5

PROJECT DATA SHEET

BIG HILL - 140 MMB

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
Facilities (in Millions of $)												
Nominal (Budget) Dollars												
BA	1	81	390	78	64	42	40	50	53	-	-	799
BO		47	184	221	130	58	41	56	50	7	5	799
Real (1981) Dollars		43	152	166	89	36	23	29	23	3	2	566
PV in 1981 of Real Dollars		39	126	125	61	22	13	15	11	1	1	414
Cumulative Fill Capability (MMB)							13	60	140	140	140	
Annual Fill (MMB)							13	47	80			140
Oil Price:												
Nominal Dollars							64.65	69.61	74.94			
Real Dollars							45.06	46.42	47.81			
Oil Cost (in Millions of $)												
Nominal Dollars							840	3272	5995			10107
Real Dollars							586	2182	3825			6593
PV in 1981 of Real Dollars							331	1120	1784			3235

TABLE A-6
PROJECT DATA SHEET
NEW 120 MMB SOLUTION-MINED SITE

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
Facilities (in Millions of $)												
Nominal (Budget) Dollars												
BA			66	145	397	202	60	66	73	40		1049
BO			55	131	355	236	84	65	72	45	6	1049
Real (1981) Dollars			45	98	242	147	47	33	34	19	2	667
PV in 1981 of Real Dollars			37	74	165	91	27	17	16	8	1	436
Cumulative Fill Capability (MMB)								14	60	120	120	
Annual Fill (MMB)								14	46	60		120
Oil Price:												
Nominal Dollars								69.61	74.94	80.02		
Real Dollars								46.42	47.81	49.24		
Oil Cost (in Millions of $)												
Nominal Dollars								975	3447	4801		9223
Real Dollars								650	2199	2954		5803
PV in 1981 of Real Dollars								334	1026	1252		2612

TABLE A-7
PROJECT DATA SHEET
COTE BLANCHE - 40 MMB

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
Facilities (in Millions of $)											
Nominal (Budget) Dollars											
BA		213	4	7							224
BO		54	106	61	3						224
Real (1981) Dollars		49	88	46	2						185
PV in 1981 of Real Dollars		45	73	35	1						154
Cumulative Fill Capability (MMB)				18	40	40	40	40	40	40	
Annual Fill (MMB)				18	22						40
Oil Price:											
Nominal Dollars				51.11	55.51						
Real Dollars				41.24	42.48						
Oil Cost (in Millions of $)											
Nominal Dollars				920	1221						2141
Real Dollars				742	935						1677
PV in 1981 of Real Dollars				557	639						1196

TABLE A-8

PROJECT DATA SHEET

STEEL TANKS - 40 MMB

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
Facilities (in Millions of $)											
Nominal (Budget) Dollars											
BA	6	496		1	2	3	5	5			518
BO		38	58	105	117	104	60	36			518
Real (1981) Dollars		35	48	79	80	65	34	18			359
PV in 1981 of Real Dollars		32	40	59	55	40	19	9			254
Cumulative Fill Capability (MMB)					8	20	32	40	40	40	
Annual Fill (MMB)					8	12	12	8			40
Oil Price:											
Nominal Dollars					55.51	60.02	64.65	69.61			
Real Dollars					42.48	43.75	45.06	46.42			
Oil Cost (in Millions of $)											
Nominal Dollars					444	720	776	557			2497
Real Dollars					340	525	541	371			1777
PV in 1981 of Real Dollars					232	326	305	191			1054

TABLE A-9

PROJECT DATA SHEET

STEEL TANKS - 30 MMB

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
Facilities (in Millions of $)											
Nominal (Budget) Dollars											
BA	6	29	388	1	2	3	4				433
BO		35	1	104	135	86	72				433
Real (1981) Dollars		32	1	78	92	53	41				297
PV in 1981 of Real Dollars		29	1	59	63	33	23				208
Cumulative Fill Capability (MMB)					8	20	30	30	30	30	
Annual Fill (MMB)					8	12	10				30
Oil Price:											
Nominal Dollars					55.51	60.02	64.65				
Real Dollars					42.48	43.75	45.06				
Oil Cost (in Millions of $)											
Nominal Dollars					444	720	647				1811
Real Dollars					340	525	451				1316
PV in 1981 of Real Dollars					232	326	255				813

TABLE A-10
BUDGET AUTHORITY REQUIREMENTS
750 MMB BASELINE SYSTEM
(BA IN MILLIONS OF DOLLARS)

	Through FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	After FY 1987	TOTAL[1]
500 MMB BASE MODULE										
Planning	48	8	9	9	8	6	6	6		100
Oil Acquisition and Transportation	3,478	3,230[2]	3,684	4,328	2,920	4,348	3,032	111		25,136
Storage Facilities Development	1,396	81	94	161	147	136	108	82		2,205
Program Direction	29	11	12	12	13	13	13	14		118
Subtotal	4,951	3,330	3,799	4,510	3,088	4,503	3,159	213		27,56
30 MMB WEST HACKBERRY EXPANSION										
Oil Acquisition and Transportation					+4	-1,031	+1,280	+1,254	+641	+2,144
Storage Facilities Development		+1	+3	+30	+13	+13	+15	+17		+96
140 MMB BIG HILL										
Oil Acquisition and Transportation							+430	+3,744	+5,943	+10,117
Storage Facilities Development		+1	+81	+390	+78	+64	+42	+40	+103	+799
TOTAL BASELINE SYSTEM										
Planning	48	8	9	9	8	6	6	6		100
Oil Acquisition and Transportation	3,478	3,230	3,684	4,328	2,924	3,317	4,752	5,109	6,584	37,406
Storage Facilities Development	1,396	83	178	585	238	213	165	139	103	3,100
Program Direction	29	11	12	12	13	13	13	14		118
TOTAL BA[1]	4,951	3,332	3,883	4,934	3,183	3,549	4,926	5,268	6,687	40,721
Outlays	2,413	3,401	3,625	3,805	4,429	2,424	4,947	4,734	10,008	40,626

[1] Totals may not agree with detail due to rounding

[2] Includes $542 million of entitlements

CUMULATIVE FILL CAPACITY
(MMB END OF FISCAL YEAR)

	Through 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Base Module	250	251	267	343	417	467	551	533	500	580	580
West Hackberry						-11	-25	+18	30	30	30
Big Hill							12	60	140	140	
750 MMB System Total	250	251	267	343	417	456	538	611	670	750	750
Annual Fill (MMB)				76	74	39	82	73	59	80	
Average Daily Fill (MBD)				208	203	107	225	200	162	219	

TABLE A-11
BUDGET AUTHORITY REQUIREMENTS
790 MMB UNDERGROUND SYSTEM
(BA IN MILLIONS OF DOLLARS)

	Through FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	After FY 1987	TOTAL[1]
750 MMB BASELINE SYSTEM (TABLE A-10)	4,951	3,333	3,883	4,933	3,183	3,550	4,935	5,268	6,687	40,724
40 MMB COTE BLANCHE INCREMENT										
Planning										
Oil Acquisition and Transportation					+2,141					+2,141
Storage Facilities Development			+213	+4	+7					+224
Program Direction			+1	+2		+1	+1			+5
TOTAL 790 MMB SYSTEM										
Planning	48	8	9	9	8	6	6	6		100
Oil Acquisition and Storage	3,478	3,230	3,684	4,328	5,065	3,317	4,752	5,109	6,584	39,547
Storage Facilities Development	1,396	83	391	589	245	213	165	139	103	3,324
Program Direction	29	11	13	14	14	14	14	14		123
TOTAL BA[1]	4,951	3,333	4,097	4,939	5,332	3,550	4,936	5,269	6,687	43,094
OUTLAYS	2,413	3,401	3,680	3,952	5,105	3,955	4,947	4,735	10,808	42,995

[1] Totals may not agree with detail due to rounding

CUMULATIVE FILL CAPACITY
(MMB END OF FISCAL YEAR)

	Through 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
750 MMB Baseline System	250	251	267	343	417	456	538	611	670	750	750
Cote Blanche	—	—	—	—	18	40	40	40	40	40	40
790 MMB System Total	250	251	267	343	435	496	578	651	710	790	790
Annual Fill (MMB)				76	92	61	82	73	59	80	
Average Daily Fill (MBD)				208	252	167	225	200	162	219	

TABLE A-12
BUDGET AUTHORITY REQUIREMENTS
890 MMB MIXED SYSTEM
(BA IN MILLIONS OF DOLLARS)

	Through FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	After FY 1987	FY 1987	TOTAL[1]
790 MMB UNDERGROUND SYSTEM (TABLE A-11)	4,951	3,333	4,097	4,939	5,332	3,550	4,936	5,269	6,687	43,094
100 MMB STEEL TANKS INCREMENT										
Planning			+2	+1						+3
Oil Acquisition and Transportation					+666	+1,746	+2,114	+1,314	+279	+6,119
Storage Facilities Development		+18	+554	+776	+1	+6	+9	+13	+5	+1,384
Program Direction			+1			+1	+1	+1	+2	+6
TOTAL 890 MMB MIXED SYSTEM										
Planning	48	8	11	10	8	6	6	6		103
Oil Acquisition and Transportaiton	3,478	3,230	3,684	4,320	5,731	5,063	6,866	6,423	6,863	45,066
Storage Facilities Development	1,396	101	945	1,365	248	219	174	152	108	4,708
Program Direction	29	11	14	14	14	15	15	15	2	129
TOTAL BA[1]	4,951	3,351	4,654	5,716	6,001	5,303	7,060	6,597	6,973	50,606
OUTLAYS	2,413	3,401	3,791	4,013	5,418	5,564	7,315	7,017	11,576	50,507

[1] Totals may not agree with detail due to rounding

CUMULATIVE FILL CAPACITY
(MMB END OF FISCAL YEAR)

	Through 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
790 MMB System	250	251	267	343	435	496	578	651	710	790	790
100 MMB Steel Tanks						24	60	92	100	100	100
890 MMB System Total	250	251	267	343	435	520	638	743	810	890	890
Annual Fill (MMB)				76	92	85	118	105	67	80	
Average Daily Fill (MBD)				208	252	233	323	288	184	219	

TABLE A-13
BUDGET AUTHORITY REQUIREMENTS
1,000 MMB MIXED SYSTEM
(BA IN MILLIONS OF DOLLARS)

	Through FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	After FY 1987	TOTAL[1]
890 MMB MIXED SYSTEM (TABLE A-12)	4,951	3,351	4,654	5,716	6,001	5,303	7,060	6,597	6,973	50,606
110 MMB SALT DOME INCREMENT										
Planning			+4	+2	+2	+2	+1	+1	+2	+14
Oil Acquisition and Transportation								+487	+7,936	+8,423
Storage Facilities Development				+66	+185	+397	+202	+60	+179	+1,049
Program Direction				+1	+1	+1	+1	+1	+5	+10
TOTAL 1,000 MMB MIXED SYSTEM										
Planning	48	8	15	12	10	8	7	7	2	117
Oil Acquisition and Transportation	3,478	3,230	3,684	4,328	5,731	5,063	6,866	6,910	14,799	54,089
Storage Facilities Development	1,396	101	945	1,431	393	616	376	212	287	5,757
Program Direction	29	11	14	15	15	16	16	16	7	139
TOTAL BA[1]	4,951	3,351	4,658	5,785	6,149	5,703	7,264	7,146	15,095	60,102
OUTLAYS	2,413	3,401	3,795	4,071	5,552	5,922	7,553	7,103	20,193	60,002

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[1] Totals may not agree with detail due to rounding

CUMULATIVE FILL CAPACITY
(MMB END OF FISCAL YEAR)

	Through 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
890 MMB System	250	251	267	343	435	520	638	743	810	890	890
110 MMB Salt Dome	—	—	—	—	—	—	—	—	14	60	110
1,000 MMB System Total	250	251	267	343	435	520	638	743	824	950	1,000
Annual Fill (MMB)				76	92	85	118	105	81	126	50
Average Daily Fill (MBD)				208	252	233	323	288	216	345	137

TABLE A-14
BUDGET AUTHORITY REQUIREMENTS
1,000 MMB STEEL TANKS SYSTEM
(BA IN MILLIONS OF DOLLARS)

	Through FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	After FY 1987	TOTAL[1]
890 MMB MIXED SYSTEM (TABLE A-12)	4,951	3,351	4,654	5,716	6,001	5,303	7,060	6,597	6,973	50,606
110 MMB STEEL TANKS INCREMENT										
Planning			+3	+2	+2	+2	+1	+1	+2	+13
Oil Acquisition and Transportation						+720	+1,881	+2,345	+2,383	+7,329
Storage Facilities Development			+18	+115	+1,294	+3	+6	+9	+24	+1,469
Program Direction			+1	+1	+1	+1	+1	+1	+3	+9
TOTAL 1000 MMB STEEL TANKS SYSTEM										
Planning	48	8	14	12	10	8	7	7	2	116
Oil Acquisition and Transportation	3,478	3,230	3,684	4,328	5,731	5,783	8,747	8,768	9,246	52,995
Storage Facilities Development	1,396	101	963	1,480	1,542	222	180	161	132	6,177
Program Direction	29	11	15	15	15	16	16	16	5	138
TOTAL BA[1]	4,951	3,351	4,676	5,834	7,298	6,029	8,949	8,953	11,385	59,426
OUTLAYS	2,413	3,401	3,795	4,127	5,538	5,881	9,005	9,562	15,606	59,327

[1] Total may not agree with detail due to rounding

CUMULATIVE FILL CAPACITY
(MMB END OF FISCAL YEAR)

	Through 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
890 MMB System	250	251	267	343	435	520	638	743	810	890	890
110 MMB Steel Tanks							24	60	94	110	110
1,000 MMB System Total	250	251	267	343	435	520	662	803	904	1000	1000
Annual Fill (MMB)				76	92	85	142	141	101	96	
Average Daily Fill (MBD)				208	252	233	389	387	277	263	

APPENDIX B

ASSESSMENT OF IMPACT ON MODULE SCHEDULES DUE TO ADMINISTRATIVE REQUIREMENTS

APPENDIX B
ASSESSMENT OF IMPACT ON MODULE SCHEDULES DUE TO ADMINISTRATIVE REQUIREMENTS

The Strategic Petroleum Reserve Acceleration Report to the Secretary identifies and examines five options for increasing the capacity of the SPR system by 1989 with emphasis on taking steps to increase the near term (mid 80's) protection provided by a Strategic Reserve.

In examining the feasibility of acceleration, it is apparent that there are two major areas of constraint to acceleration even if funding is assumed to be of no concern. One is in the area of technical feasibility; the other is in the area of legal barriers which must be satisfied.

All options presented in this report are technically feasible, have development schedules that maximize all opportunities to accelerate program implementation, and are fully consistant with the plans developed for the strategic deployment of Reserve inventories. In identifying these five options, many other options that had either been considered in the past, or were being currently considered as alternatives were assessed but not presented because they were either technically infeasible, or could not conform to the requirement to develop options that would assure increased capacity over the period of time (through 1989) on which SPR development is focused.

Since the development plans for all five options are at a maximum technical feasibility level, no reengineering of design and construction is seen as a means to significantly contribute to acceleration of the schedule. In the case of legal barriers, however, a close examination of the issues involved indicated that in general, to the maximum possible extent these issues are planned for solution or accomplishment concurrent with the technical design and construction activities. Thus, it impossible to foresee in advance when these requirements, althrough very expensive and time consuming, will impinge on the overall critical path of the option. Thus, the development plans are designed to not only maximize technical feasibility, but to the extent possible to minimize the potential impact of legal and other administrative barriers on the option's development schedule.

However, it needs to be recognized that without a decision to seek in advance of such relief as a Presidential environmental exemption, all schedules are problematic and subject to delay. This is especially true for new developments such as steel tanks and a new solution-mined site, which may engender environmental opposition.

It is also worth noting that the potential advantages provided in Sec. 101(a) and (c) of the Defense Production Act (DPA) have been assessed and the conclusion has been reached that neither offers significant opportunities to overcome the potential generic problems with the supply of long lead time equipment. If a specific issue at a specific time seems capable of resolution by invoking the DPA, then it will be used.

The four major areas of legal or administrative constraints that could affect SPR acceleration are:

- publishing an Environmental Impact Statement,
- negotiating for land acquisition,
- obtaining and utilizing needed environmental permits, and
- executing a business strategy that minimizes procurement time delays.

The following discussion of each of the modules presented in the SPR acceleration report addresses each of these major legal or administrative barriers and discusses the specific plan for minimizing the adverse affect on the acceleration objective. These issues are summarized in Figure B.1: Adminsitrative Barriers to Acceleration - Assessment of Constraints.

Base Module at 580 Million Barrels

This Base Module consists of 250 million barrels of storage capacity completed in Phase 1, 290 million barrels of storage capacity in Phase II which is substantially complete and the acceleration of the 40 million barrels of storage capacity at the Bryan Mound location originally

Figure B.1. Administrative Barriers to Acceleration - Assessment of Constraints

	ENVIRONMENTAL IMPACT STATEMENT	LAND ACQUISITION	PERMITS	BUSINESS STRATEGY
Base Module	No EIS action unaccomplished.	Not applicable to Base Module.	EPA approval required of brine disposal permit to increase average daily rate from 680 MMB to 980 MMB from Bryan Mound. Permit modification applied for in Feb 1981.	No problems foreseen.
West Hackberry (both modules)	Supplement required for Phase III-scheduled for completion Oct 1981. • Not on critical path	Shortest time may begin upon completion of EIS (Oct-81) process requires 1 year. • Not on critical path	Scheduled for acquisition by mid CY 1983. • Not on critical path	No viable method for accelerating the procurement process yields scheduling benefits. • Of minor significance to critical path
Big Hill	Supplement required for Phase III - included in West Hackberry action. • Not on critical path	Shortest time - same time frame as West Hackberry. • Not on critical path	Ample time provided in development plan. No need for waivers anticipated. • Not on critical path	Principal constraints related to tight market conditions. • No significant opportunity to affect critical path
Cote Blanche	Basic EIS published 1977 - supplement expected to require 1 year - waiver saves 5 mos. • Waiver provides no significant opportunity to affect critical path.	Est. begin mid FY 1983. • Critical path unaffected	No brine disposal issue. Other permits seen to be routine. • Not on critical path	Schedule for development is currently at optimum level. No viable method for accelerating the procurement process yields scheduling benefits. • No significant opportunity To affect critical path
New Solution-Mined Site	Basic EIS requires 18 months - 12 months are on critical path. If EIS requirement did not exist, schedule could be reduced by one year.	Condemnation needs 1 year after EIS. Negotiation could be shorter if concurrent with EIS. • Not on critical path	Permits to be sought concurrent with LLE, design, and site development. • Not on critical path	Principal constraint to acceleration of schedule is related to tight market conditions. • No significant opportunity to affect critical path
Tank Farms (systems alternatives 3 and 5)	EIS not in critical path because design process for tank farm can proceed concurrently. • Not on critical path	Not in critical path - EIS and acquisitional land occur concurrent with system design. • Not on critical path	Permits could be difficult with respect to Clean Air Act. Schedule more than 24 months to resolve this problem before permits affect the critical path. • Not on critical path	Design/procurement schedule concurrent with EIS/Land Acq. Schedule. No viable method for accelerating the procurement process yields scheduling benefits. • No significant opportunity to affect critical path

scheduled in Phase III. This acceleration of 40 million barrels of storage capacity is made possible by the change in the EPA brine disposal permit to allow brine discharge from Bryan Mound into the Gulf of Mexico at a daily average rate of 980 million barrels rather than an average daily rate of 680 million barrels. Additionally, pumps are scheduled for installation late in 1981 to achieve this higher rate of leaching. Because of the very advanced state of SPR site development, the only environmental barrier outstanding is the actual approval of the brine disposal permit modification and this is not expected to be a problem. No land acquisition issues remain for the Basic Module and no business strategy problems remain to affect completion according to the accelerated schedule. Of course, delays are possible as a result of EPA monitoring of time discharge pursuant to the issued permit, but such problems cannot presently be predicted, and will have to be dealt with as they develop.

West Hackberry Module (Both Subalternatives)

This acceleration module contemplates the addition of 30 million barrels of storage capacity to the SPR by 1988 with oil fill beginning late in FY 1985. The schedule for developing this module is not jeopardized to any significant degree by problems associated with environmental requirements; the supplement to the EIS for West Hackberry that covers the module is scheduled for completion in October 1981 and the required environmental permits are scheduled for acquisition by mid calendar year 1983. Neither of these requirements presently is on the development plan's critical path. The land acquisition element of this module is scheduled to require one year after the completion of the EIS supplement. This is an optimal land acquisition schedule because for planning purposes it assumes land acquisition by condemnation after negotiations. Even though land acquisition will require one year under condemnation procedures, the land acquisition element is not currently on this module's development plan critical path. Throughout this module's development plan, the critical path is essentially constrained by technical feasibility and the potential impact of tight market conditions on long lead time equipment. Given these conditions, there do not appear to be significant opportunities to improve upon the current development plan's schedule by waiving environmental permits or other requirements relating to procurement.

Big Hill

This module for SPR acceleration involves a site that has not yet been acquired for salt cavern storage development. However, environmental analyses have been completed and a process has been established for selecting an architect/engineer. The environmental impact statement requirements for Big Hill will be met with the completion of the supplement for West Hackberry in October 1981. Land acquisition is scheduled to require one year after the completion of the EIS supplement in October 1981. This time frame does not present a schedule barrier since land acquisition is not on the critical path.

The acquisition of permits is planned to occur concurrent with design and construction and, at the present time, the utilization of permit waivers is not seen as reducing the time required to implement the Big Hill development plan. As was the case in the West Hackberry module, the critical path is essentially tied to technical feasibility, i.e., design, construction, and brine leach rate, with some concern for the impact of tight market conditions on delivery of long lead time equipment.

Cote Blanche

In this module, the Strategic Petroleum Reserve would acquire (with condemnation a serious possibility) an operating salt mine at Cote Blanche, Louisiana. The estimated storage capacity of this mine is 40 million barrels; it offers the prospect of 40 million barrels of additional protection by early in FY 1985. This very fast acceleration module is enhanced by the fact that the basic EIS was in place as of 1977 and only a supplement is required before operations could begin. This is expected to take one year and would occur concurrent with procurement of contractors and equipment. If the requirement for an environmental impact statement supplement were legislatively waived, the schedule could be advanced by five months. The land acquisition process is planned to require one year. This time frame does not present a schedule barrier since land acquisition is not in the critical path. As in the other modules, design and site construction time requirements are the critical path elements. Environmental permits are not expected to be impediments to maximum schedule implementation because the Cote Blanche mine will not require brine disposal. The other permits required are considered routine and capable of being acquired well within the time required for the technical critical path. At this time, it does not seem that the use of sole source procurement procedures could accelerate the development plan significantly. As in the other modules, however there is a possible constraint on the schedule if the tight market conditions adversely affect equipment supply. Thus, it is the tight market rather than the type of procurement procedure used that is seen as being a potential schedule problem.

New Solution-Mined Site

In this module, the Strategic Petroleum Reserve contemplates identifying and acquiring a new site, developing the site, and creating 120 million barrels of storage capacity. Because no site specific cost, design schedule, or environmental analyses have been conducted, the time frames for EIS, land acquisition, permits, and procurement strategy are potentially more significant than in the preceding modules. However, an examination of the development plan for a new salt cavern site shows that the critical path is determined much more by the technical issues of design, construction and rate of leaching than by the administrative/legal issues. A new EIS is expected to require 18 months of which 12 months are on the critical path. If the requirement for an EIS is waived, the schedule for developing the new solution-mined site module would be advanced by approximately one year resulting in completion of planned storage capability one year earlier. Land acquisition is planned to require one year; this time frame does not present a schedule barrier since it is not on the development plan critical path. The permitting process is not on the critical path; it would occur concurrent with the design and site development elements of the development plan. As in the previous modules, the tight market for equipment supply is seen as being a potential threat to the optimal accomplishment of the development plan for the new solution-mined site.

Tank Farms

This module involves an entirely new approach for Strategic Petroleum Reserve storage: storage of very large amounts of oil above the ground. In all other modules and in existing SPR sites, the Reserve oil is held either in underground mines or caverns leached from salt domes. This has not only been less expensive, but it has avoided some real socio-economic problems that are associated with extremely large above ground storage facilities. However, given the initial objective of this report; increase the capacity of the SPR system with emphasis on taking steps to increase near term (mid-80's) protection, steel tanks become a very appropriate option because of relatively fast development feasibility.

The potential environmental barriers associated with this module are significantly greater than those associated with the various underground storage modules. The principal problem would involve the permitting requirements under the Clean Air Act (CAA). In areas of the country where the level of pollutants in the air exceed the national standards under the CAA, no new major emission sources can be constructed unless the facilities use the latest in air pollution control equipment. Further, any increase in pollution resulting from the facility must be offet by a greater reduction in like pollutants from existing facilities. In the past this policy has not been applicable to SPR underground facilities because emissions have not been large enough to have the SPR facilities classified as major emission sources but steel storage tanks may be classified as major emissions sources. As the Government is not now a major source of hydrocarbon emissions in the Gulf, emissions offsets probably would have to be obtained by reducing emissions from private sources. However, while a private storage firm could pay another existing source the cost of installing pollution control equipment in order to obtain the necessary "offsets", the Government is prohibited from paying for improvements to private property absent specific authority from Congress. Thus the CAA could pose a significant problem which must be overcome if steel tanks are to be a viable module.

If program acceleration is considered to be a very high priority, this problem could be overcome by the President exercising his authority to waive the CAA as it applies to the SPR. In addition, should delays in schedule occur because of unexpected problems with the Environmental Impact Statement, relief could be sought by seeking a legislative waiver to the National Environmental Policy Act (NEPA).

In addition to the potential problems with the EIS and permitting process, land acquisition even by condemnation could present significant problems. The problem is that tank farm storage for many millions of barrels of oil is very large and obtrusive. Such an installation or group of installations is likely to meet with significant local resistance. A judicious site selection process could overcome much local opposition but it is appropriate to note that at best, a tank farm is likely to engender local opposition.

Procurement strategy is not seen as a significant problem other than the usual problem with tight market conditions and their potential impact on equipment delivery schedules. Steel tank storage is a familiar storage medium and design can begin at the same time as site selection and environmental impact statement.

STATEMENT OF

THE INTERNATIONAL BROTHERHOOD OF BOILERMAKERS, IRON SHIPBUILDERS, BLACKSMITHS, FORGERS AND HELPERS, AFL-CIO

BEFORE THE

SENATE COMMITTEE ON GOVERNMENTAL AFFAIRS

SUBCOMMITTEE ON ENERGY, NUCLEAR PROLIFERATION,
AND GOVERNMENT PROCESSES

ON

THE STRATEGIC PETROLEUM RESERVE

WASHINGTON, D.C.
MAY 21, 1982

International Brotherhood of
BOILERMAKERS · IRON SHIP BUILDERS · BLACKSMITHS · FORGERS & HELPERS
New Brotherhood Building *Kansas City, Kansas 66101*

HAROLD J. BUOY
INTERNATIONAL PRESIDENT
CHARLES F. MORAN
INTERNATIONAL SECRETARY-TREASURER

MR. CHAIRMAN, AND MEMBERS OF THE SUBCOMMITTEE, MY NAME IS VICTOR MAGGIO. I AM AN INTERNATIONAL REPRESENTATIVE OF THE CONSTRUCTION DIVISION OF THE INTERNATIONAL BROTHERHOOD OF BOILERMAKERS, IRON SHIPBUILDERS, BLACKSMITHS, FORGERS AND HELPERS, AFFILIATED WITH THE AFL-CIO. ON BEHALF OF HAROLD J. BUOY, INTERNATIONAL PRESIDENT OF OUR ORGANIZATION, REPRESENTING ONE HUNDRED FORTY THOUSAND (140,000) MEMBERS IN THE UNITED STATES AND CANADA, I THANK YOU FOR THIS OPPORTUNITY TO ADDRESS AN ISSUE OF GREAT CONCERN TO THIS INTERNATIONAL BROTHERHOOD, THE STRATEGIC PETROLEUM RESERVE (SPR).

THE INTERNATIONAL BROTHERHOOD OF BOILERMAKERS FIRMLY BELIEVES THAT THE STRATEGIC PETROLEUM RESERVE IS VITAL TO THE SECURITY OF OUR NATION. OUR ORGANIZATION SUPPORTS A STRONG NATIONAL DEFENSE POLICY, REALIZING THE DIRECT RELATION OF AN ADEQUATE OIL RESERVE AND OUR ABILITY TO DEFEND OUR COUNTRY. FOR THAT REASON, WE ARE IN CONCURRENCE WITH THE ORIGINAL GOAL OF IMPLEMENTING LEGISLATION PASSED BY CONGRESS, ESTABLISHING, AS QUICKLY AS POSSIBLE, A SEVEN HUNDRED FIFTY MILLION BARREL (750 MMB) OIL RESERVE, AND TOTALLY SUPPORT THE PRIORITY AND URGENCY RECENTLY ATTACHED BY CONGRESS TO THE DEVELOPMENT AND FILL OF THE SPR.

MR. CHAIRMAN, IT IS OUR UNDERSTANDING THAT CURRENT ESTIMATES PROJECT BETWEEN TWO HUNDRED FORTY AND TWO HUNDRED SEVENTY MILLION BARRELS (240-270 MMB) OF CRUDE OIL BEING IN PLACE AT THE END OF THIS CALENDAR YEAR. THIS REPRESENTS APPROXIMATELY ONE HALF (1/2) OF THE TOTAL AMOUNT OF THE GOAL PROVIDED IN THE INITIAL LEGISLATION.

IN TESTIMONY BY CONGRESSMAN MARC L. MARKS OF PENNSYLVANIA, BEFORE THE HOUSE SUBCOMMITTEE ON FOSSIL AND SYNTHETIC FUELS ON MARCH 2, 1982, HE EXPLAINED, "ALTHOUGH ADVERSE MARKET CONDITIONS PRECLUDED SIGNIFICANT FILL DURING THE 1979 - 1980 TIME FRAME, THIS SHOULD NOT HAVE ADVERSELY AFFECTED THE DEVELOPMENT OF CAPACITY. HE FURTHER STATED, "THE ADMINISTRATION NOW RECOMMENDS THAT COMPLETION OF THE TOTAL CAPACITY OF THE RESERVE, TO THE SEVEN HUNDRED FIFTY MILLION BARREL (750MMB) LEVEL, SHOULD BE FURTHER DELAYED BY ONE YEAR UNTIL THE END OF FISCAL YEAR 1990."

IT IS ONLY TOO OBVIOUS THAT THE ADMINISTRATION, NOT ONLY ACCEPTS THE CURRENT PHYSICAL CONSTRAINTS OF THE EXISTING SALT DOMES, BUT FURTHER SUGGESTS DEFERRING PLANS TO INCREASE CAPACITY, THUS REDUCING THE FILL RATE SUBSTANTIALLY. IT IS OUR OPINION THAT THE ADMINISTRATION'S POSITION IS DEFINITELY CONTRARY TO THE INTENT OF CONGRESS TO FILL THE RESERVE AS QUICKLY AS POSSIBLE.

FURTHERMORE, WE BELIEVE THE ADMINISTRATION'S POSITION FUNDAMENTALLY DEFEATS THE PURPOSE OF THE STRATEGIC PETROLEUM RESERVE, "WHICH IS TO MINIMIZE, IF NOT IMMUNIZE OURSELVES AGAINST THE ADVERSE POLITICAL AND ECONOMIC EFFECTS INHERENT IN ANOTHER CRUDE OIL SUPPLY INTERRUPTION".[1]

OUR INTERPRETATION OF THESE CIRCUMSTANCES CAN ONLY SUPPORT CLAIMS OF HISTORICAL MISMANAGEMENT, MAGNIFIED BY DELAY. MR. CHAIRMAN, AND MEMBERS OF THE SUBCOMMITTEE, THIS INTERNATIONAL UNION CANNOT IMPRESS UPON YOU ENOUGH AS TO THE IMPORTANCE AND NEED FOR IMMEDIATE PLANS TO DEVELOP CAPACITY AND FILL THE RESERVE. WE CAN NO LONGER TOLERATE THE COMPLACENCY OF THE ADMINISTRATION AND ALLOW FURTHER DELAY OF THE DEVELOPMENT AND FILL OF THE SPR.

THUS, THE INTERNATIONAL BROTHERHOOD OF BOILERMAKERS, IRON SHIPBUILDERS, BLACKSMITHS, FORGERS AND HELPERS ARE IN FAVOR OF SUBSTITUTING ABOVE-GROUND STEEL TANK STORAGE TERMINALS IN PLACE OF SALT-DOME TYPE STORAGE IN PHASE III OF THE CURRENT PLAN. SPECIFICALLY, WE SUPPORT EXPANSION OF THE SPR TO THE DESIRED SEVEN HUNDRED FIFTY MILLION BARREL (750 MMB) CAPACITY VIA THE

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[1] Exerpt from testimoney of congressman Marc L. Marks before the House subcommittee on Fossil and Synthetic Fuels on March 2, 1982.

CONSTRUCTION OF ONE HUNDRED FORTY MILLION BARRELS (140 MMB) OF ABOVE-GOUND STEEL TANK STORAGE CAPACITY RATHER THAN A SIMILAR INCREASE THROUGH THE DEVELOPMENT OF IN-GROUND TYPE STORAGE PROPOSED AT THE BIG HILL SALT-DOME LOCATED IN TEXAS.

ABOVE-GOUND STEEL TANK STORAGE CAN BE CONSTRUCTED FASTER, COST EFFECTIVELY, AND BE IN PLACE FOR FILLING IN LESS TIME THAN SALT-DOME TYPE STORAGE. EQUALLY IMPORTANT, THE INCLUSION OF ABOVE-GROUND STEEL TANK STORAGE TERMINALS WOULD BE TREMENDOUSLY LABOR INTENSIVE AND CONTRIBUTE TO THE IMPROVEMENT OF THE ECONOMY. THE FOLLOWING FACTS WILL SUPPORT AND SUBSTANTIATE OUR POSITION:

1) RESULTS OF A STUDY PREPARED BY THE STEEL PLATE FABRICATORS ASSOCIATION, WHICH HAS BEEN SUBMITTED TO YOU AND INCLUDED IN THEIR TESTIMONY, "CLEARLY SHOWS THAT STORAGE AVAILABILITY CAN BE ACCELERATED BY PROCEEDING IMMEDIATELY WITH ABOVE-GROUND STEEL TANK TERMINALS." FURTHER SUBSTANTIATED, "...THE ONLY STORAGE MODE THAT CAN BE DEVELOPED IN SUFFICIENT VOLUME QUICKLY ENOUGH TO MAKE AN APPRECIABLE IMPACT ON THE SEVEN HUNDRED FIFTY MILLION BARREL (750 MMB) STORAGE TIMETABLE IS THE ABOVE-GROUND STEEL TANK ALTERNATIVE."[2]

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[2] IBID

2) In a report conducted by the U.S. Department of Energy, In July, 1981, entitled "Strategic Petroleum Reserve Acceleration: Report to the Secretary," analysis of costs between the construction of above-ground steel tanks froved to be less expensive than development of a new solution-mined site and in terms of overall budget costs, competitive to the Big Hill alternative, basically due to the timely acquisition of oil in both instances. The U.S. Corps of Engineers' analysis, dated October 19, 1981, suppports DOE's findings and takes the position that comparatively above-ground storage terminals are cost effective.

3) Substitution of one hundred forty million barrels (140 MMB) of above-ground steel tank storage for an equal amount of in-ground storage would allow for a three to four (3-4) year acceleration of the SPR and accomplish establishment of the total Reserve. By creating additional storage capacity in less time than anticipated, the U.S. could take advantage of the existing oil glut, reduce overall costs, place the entire Reserve in tact, and afford Americans the protection of a seven hundred fifty million barrel (750 MMB) SPR, thus accomplishing the objective of the program.

4) Additional advantages of above-ground steel tank storage over in-ground salt dome storage are numerous. Steel tanks permit

A GREATER PERCENTAGE OF OIL TO BE RETRIEVED THAN IN-GROUND STORAGE. TO FACILITATE THE DISTRIBUTION OF OIL, STEEL TANK STORAGE TERMINALS CAN BE GEOGRAPHICALLY LOCATED TO COMPLEMENT THE EXISTING OIL PIPELINES, WHICH IS UNTRUE OF SALT-DOME STORAGE FACILITIES. ALSO, THE CONSTRUCTION OF STEEL TANKS CAN BE LOCATED STRATEGICALLY IN AREAS THAT ENHANCE OUR NATIONAL DEFENSE CAPABILITIES, AS WELL AS PROVIDE SECURITY FOR THE RESERVE, WHICH IS NOT POSSIBLE AND CHARACTERISTIC OF IN-GROUND STORAGE. SHOULD NEED ARISE AT A FUTURE DATE, STEEL TANK STORAGE TERMINALS OFFER THE FLEXIBILITY FOR ALTERNATIVE STORAGE USES, WITH EASY CONVERSION TO PRODUCT STORAGE. IN THEORY, ABOVE-GROUND STEEL TANKS PROVIDE A MODE OF STORAGE APPLICABLE FOR ALMOST ANY SUBSTANCE AND ALLOWS FOR TOTAL RETRIEVABILITY, WHICH CANNOT BE ACHIEVED IN SALT-DOME TYPE STORAGE.

5) MOST IMPORTANTLY, UTILIZATION OF ABOVE-GROUND STEEL TANK STORAGE REPRESENTS A FAR GREATER JOB-CREATING POTENTIAL THAN IN-GROUND SALT-DOME STORAGE. MANPOWER PROJECTIONS, RELATIVE TO THE INCLUSION OF ABOVE-GROUND STEEL TANK STORAGE TERMINALS IN PHASE III OF THE CURREN PLAN, ARE ASTRONOMICAL IN TERMS OF MAN YEARS OF EMPLOYMENT. THE INCORPORATION OF STEEL TANKS TO THE PLAN WOULD REQUIRE THE PRODUCTION OF MORE THAN FOUR HUNDRED THOUSAND (400,000) TONS OF STEEL AND PROVIDE THE CURRENTLY DEPRESSED STEEL INDUSTRY WITH OVER SEVENTEEN HUNDRED (1,700) MAN YEARS OF EMPLOYMENT. ADDITIONALLY, YEARS

OF EMPLOYMENT WOULD BE CREATED FOR PEOPLE IN THE MINING OF RAW MATERIALS ASSOCIATED WITH STEEL PRODUCTION, AS WELL AS THE SHIPPING INDUSTRY FOR THE HANDLING AND TRANSPORTATION OF THE MATERIALS.

FURTHERMORE AND AS IT SPECIFICALLY APPLIES TO THE CONSTRUCTION INDUSTRY, STEEL TANKS REPRESENT ALMOST SIX THOUSAND FIVE HUNDRED (6,500) MAN YEARS OF WORK IN THE FABRICATION AND CONSTRUCTION OF THE TERMINALS. IN AN INDUSTRY CURRENTLY PLAGUED WITH A NATIONWIDE UNEMPLOYMENT RATE BETWEEN TWENTY AND TWENTY-FIVE PERCENT (20%-25%), THE ADVANTAGES SURROUNDING THE CONSTRUCTION OF STEEL TANKS WITH REGARD TO THE ECONOMY ARE ENDLESS. WITHOUT EXPLAINING THE THEORY OF THE "RIPPLE EFFECT" AND THE DIRECT IMPACT ON THE DOMESTIC ECONOMY, WE ASK EACH OF YOU TO CONSIDER THE AFFECTS OF THIS PRINCIPLE WHICH IS MOST APPLICABLE IN THIS SITUATION. ALTHOUGH MANPOWER ESTIMATES ARE NOT AVAILABLE FOR THE DEVELOPMENT OF BIG HILL, WE ARE CERTAIN THAT SALT-DOME STORAGE IS FAR LESS JOB INTENSIVE THAN CONSTRUCTION OF ABOVE-GROUD STEEL TANK STORAGE TERMINALS

ON BEHALF OF THIS INTERNATIONAL UNION AND ONE HUNDRED THIRTY THOUSAND (130,000) AMERICAN MEMBERS, I URGE YOUR SUPPORT OF THIS PROPOSAL AND ASK THAT YOU INCLUDE ABOVE-GROUND STEEL TANK STORAGE TERMINALS AS PART OF THE STRATEGIC PETROLEUM RESERVE.

THANK YOU.

Senator **Percy**. The hearing is adjourned.

[Whereupon, at 1 p.m., the subcommittee recessed, to reconvene at the call of the Chair.]

ADDITIONAL MATERIAL SUBMITTED FOR THE RECORD

STATEMENT OF ADM. THOMAS H. MOORER

Senator Percy, thank you for this opportunity to present testimony before your Committee. I am Admiral Thomas H. Moorer, U.S. Navy, former Commander-in-Chief of U.S. Pacific Fleet; Commander-in-Chief, U.S. Atlantic Fleet and Atlantic NATO Forces; Chief of Naval Operations and Chairman of the Joint Chiefs of Staff. Currently I serve as Senior Advisers to the Georgetown Center for Strategic and International Studies.

In March of last year I submitted written testimony to your Committee recommending several actions to increase U.S. energy security.

At that time the Strategic Petroleum Reserve held about 120 million barrels. Today it holds in excess of 250 million barrels.

In March of 1981, we were daily importing 5.4 million barrels of crude oil and petroleum products. A year later imports were down to 3.5 million barrels a day.

In one year we have more than doubled our petroleum reserves and reduced our imports by about 36 percent. Impressive accomplishments—but not adequate to justify complacency.

First of all, it is generally agreed that oil consumption is down due, in part, to economic factors and will soon be on the rise.

Second, long ago I learned that a war is not won until victory is complete. We are very far from that, in spite of headlines about oil gluts. There is still cause for anxiety if we look at the availability of high grade liquid fuels during an emergency. For example, a September 1981 GAO report concluded that: "The U.S. Government is almost totally unprepared to deal with disruptions in oil imports. Oil import disruptions * * * pose a significant threat to national planning and program development to date is serious and requires immediate attention."

And in a March 9 letter to Congressman Philip Sharp, the Comptroller General wrote: "Since then, progress has been slow; there is still no comprehensive plan or even individual response plans in any contingency planning area which can be considered fully operational."

Further, in spite of greatly increased drilling, U.S. crude oil production has remained essentially the same for the past four years.

The draw down on SPRO is currently limited to 1.7 million barrels a day—far less than needed to meet even normal demands in the event of a cut off in imports. Our long-run chance for reducing dependence from overseas oil was furthered delayed when Exxon announced plans recently to mothball their giant and pace-setting oil shale plant in Colorado.

A separate problem—quite apart from our continued overall national dependence on imports and lack of adequate reserves—is that distribution and processing must now proceed through centralized and vulnerable facilities.

The number of refineries serving the United States dropped from 324 in January 1981 to 301 in January 1982. Although not a major reduction, most of the closed capacity was in PAD II, the nation's breadbasket—making the Midwest more dependent on distant sources of refined product and consequently more vulnerable to interruption. Disruption of fuel supplies at planting time by, for example, sabotage of even a portion of the pipeline network would have a major impact on our agricultural production.

The flow of oil in the United States is from highly decentralized wells—the average production is 16 barrels a day with over 385,000 stripper wells producing less than 10 barrels a day. But these decentralized wells feed into *centralized* refineries through vulnerable pipeline and transportation systems.

We are becoming increasingly aware of the vulnerability of the U.S. liquid fuel refining, storage and distribution systems in the event of wars, sabotage or terrorism.

In my written testimony last year, I made several recommendations. I have attached a copy for your review. Even though SPRO is up and imports down, I believe my recommendations remain valid.

Alcohol, both ethanol and methanol, is our most active synthetic fuel. In the past year, ethanol production capacity increased from 125,000,000 to over 300,000,000 gallons a year. Technology in both production and use continues to advance. Pilot plants to convert cellulose into ethanol are under construction.

Methanol plans using peat, coal, and woody biomass are under design. The alcohols are increasingly becoming a viable, decentralized alternative liquid fuel.

The House of Representatives is considering H.R. 6142, a bill calling for the conversion of a portion of the corn stored by the Commodity Credit Corporation into alcohol for use in the Federal fleet. There is discussion in both the Senate and the House on the creation of a Strategic Alcohol Fuel Reserve [SAFURE]—a measure I proposed last year.

I ask that you consider these two measures and my recommendations of last year. Decentralized fuel grade alcohol production and use makes utlimate sense in strengthening our energy security. We must ensure adequate supplies of high grade liquid fuels to our farming communities in the event of a natural or man-caused disaster.

The war for energy security has not been won. We appear to be better off than last year. But, we cannot let our nation and our food production go on appearances. In the case of liquid fuels, we can be assured of adequate supplies, but only if we get on with the job.

WRITTEN TESTIMONY OF ADM. THOMAS H. MOORER BEFORE THE SUBCOMMITTEE ON ENERGY, NUCLEAR PROLIFERATION, AND GOVERNMENT PROCESSES OF THE COMMITTEE ON GOVERNMENTAL AFFAIRS, MARCH 24, 1981

Senator Percy, thank you for allowing me to submit written comments for consideration by your Committee. I am Admiral Thomas H. Moorer, U.S. Navy, former Commander-in-Chief of U.S. Pacific Fleet; Commander-in-Chief, U.S. Atlantic Fleet and Atlantic NATO Forces; Chief of Naval Operations and Chairman of the Joint Chiefs of Staff. Currently I serve as Advisor to the Georgetown Center for Strategic and International Studies.

These experiences lead me to the conclusion that we must now move expeditiously to reinforce our conventional and strategic military forces and focus widespread interest on national security. The need for such actions is becoming increasingly clear to most Americans, and is being very well anticulated and pursued by the new Administration and the new Congress.

I'd like to talk specifically about two aspects of our country's preparedness: the capacity to supply high-grade liquid fuels, and reducing the vulnerability of that capacity.

With some exceptions—a few ships and a significant number of submarines driven by nuclear power, and our larger missiles powered by exotic fuels—our military cannot operate without assured supplies of petroleum-based liquid fuels.

The credibility of our military forces as a deterrent and the capability of these forces during war directly depend on the continued availability of these fuels.

Recognizing this, the Department of Defense has taken the necessary steps to ensure the availability of adequate supplies and has developed contingency plans to deal with supply interruptions. The military maintains peacetime operating stocks and a war reserve of fuel. The level of this reserve is based on a variety of factors, including size and type of forces in a particular operating theater, conditions within that theater, sortie rate for aircraft, estimated losses, and the period of time before resupply trains or ships can arrive. Fuel resupply by air is always possible, but should be held to emergency conditions.

To the extent possible, resupply from storage areas or refineries within or close to the operating theater is the preferred option. However, resupply from the United States is an option that must be available to the military.

The top national priorities for fuel during a military emergency are: first, the Defense Department itself, then defense contractors to maintain the flow of war material, and then common carriers to transport these materials to the operating areas.

Clearly there are other high national priorities for the allocation of petroleum during a military emergency such as transporting defense workers to their jobs and continuing essential services and a variety of systems needed to maintain the general productivity of the nation.

Feeding our military personnel, American citizens, and under certain conditions, our allies, must and does have a high priority in the allocation of fuel during emergencies. Further, ensuring the continuous flow of various forms of energy, in addition to petroleum, throughout the country to maintain the general productivity of the nation is also a priority national security issue. For without a functioning industrial base and an adequately fed populace, our national security and the perception of that security will be impaired. The disruption of that flow will thus be among the highest priorities of any nation intent on destroying the defense capability of the United States.

Can we ensure the flow of needed energy in the event of a national emergency? Major refineries, ports, gas and oil pipeline terminals, major electric power plants, and critical switching centers in the electrical grid are certain to be prime targets for incoming missiles.

The vulnerability of these critical points in our energy production, processing, and distribution systems was pointed out in a recent study for the Federal Emergency Management Agency entitled Dispersed, Decentralized, and Renewable Energy Sources: Alternatives to National Vulnerability and War.

The findings of that report are:

1. Current U.S. energy systems (fuels and electricity) are highly vulnerable, due to requirements for imported resources and due to the centralized nature of the systems themselves.

2. Dispersed, decentralized and renewable energy sources can reduce national vulnerability and the likelihood of war by substituting for vulnerable centralized resources.

3. National policies and goals need to be developed to strengthen current inadequate energy emergency contingency planning and incorporate decentralized and renewable energy supplies into those plans.

4. Local policies and goals need to be developed to implement the range of programs described in the concept of the Defense Energy District.

5. National energy self-sufficiency programs (including synfuel development and Strategic Petroleum Reserve) are highly centralized, thus highly vulnerable. A better strategic opportunity is the development of dispersed local and regional approaches.[1]

6. Current funding levels (both private and public) for decentralized and renewable energy are inadequate. National priorities should reflect the strategic value and importance of the decentralist/renewable energy opportunity.

The vulnerability of concentrated energy systems was put into historical perspective in the above-mentioned report: Dr. Roser, Chief Electrical Engineer for RWE, Germany's largest utility, expressed this concern when he stated, "The war would have finished two years sooner if you (the Allies) had concentrated on the bombing of our power plants earlier. . . . Your attacks on our power plants came too late. This job should have been done in 1942. Without our public utility power plants we could not have run over factories and produced war materials. You would have won the war then and would not have had to destroy our towns. Therefore, we would now be in a much better condition to support ourselves. I know the next time you will do better."

Underscoring the surprise of German officials that the Allies did not target and destroy power plants was Reichminister Albert Speer's (Minister for Armament and War Production) comments, "I think that attacks on power stations, if concentrated, will undoubtedly have the swiftest effect; certainly more quickly than attacks against steel works, for the high quality steel industry, especially electrosteel, as well as the whole production of finished goods and public life, are dependent upon the supply of electric power. . . . The destruction of all industry can be achieved with less effort via power plants."

In contrast, Japan's energy systems were less vulnerable, as reported in the conclusions of the Allied Bombing Survey:

Most of the power requirements of Japan, however, come from hydro generating plants, which are so numerous, small and inaccessible that their destruction would be impractical, if not impossible. If their supply could be eliminated or drastically curtailed by some other means, electric power supply could be reduced to a point where the shortage would assume economic importance. It has been shown that neither the transmission nor the distribution system is, of itself, vulnerable.

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[1] While I support the need for decentralized energy systems, particularly to service farms and rural communities, we will continue to need major, concentrated energy systems to power our industry and to serve metropolitan areas.

In the United States, the nature of our industry and our transportation system as well as the vastness of our land makes high grade liquid fuels our Achilles' heel during a military emergency. I believe that the farm communities of the United States, which play such a vital role during times of peace and war by providing needed food supplies, can make an important contribution to national resiliency.

Certainly, farming operations require special attention for:

They are almost totally dependent on high grade liquid fuels—gasoline and diesel.

They are at the end of the distribution pipelines for both these fuels.

Their productivity is only reached by accommodating nature's time schedule. A disrupted fuel supply at a critical time could be disastrous.

Their products must be trucked, or sent by rail or barge to the marketplace, and liquid fuel is again needed in the transportation process.

To reduce their particular vulnerability, many farmers have already begun to produce their own fuel. In the process, they are effectively building a dispersed alternate fuels capacity. A large number of decentralized alcohol plants can help ensure production and delivery of food by providing a continuous supply of high grade liquid fuels.

To reinforce national security by transforming certain farm communities from energy consumers to energy producers and by ensuring adequate back-up supplies of fuel during an emergency, we need to carefully explore a range of options such as:

Including supplies of high grade liquid fuels for farm communities in all fuel allocation contingency plans.

Encouraging farmers to maintain petroleum fuel reserves on their farms by keeping storage tanks topped off.

Reducing the dependence of the farm community on imported high grade liquid fuels by producing fuel grade alcohol within the community.

Developing Federal or State programs to encourage farmers and farm communities to establish a national Defense Alcohol Fuel Reserve to meet their needs during an emergency, as the Strategic Petroleum Reserve will serve military, industrial and urban communities. Such a program would not only provide the needed reserve, but would also stimulate the advancement of the alcohol fuels industry. This will in turn reduce our crippling dependence on imported oil, and enhance the sustainability of rural communities in the event of a prolonged or particularly damaging national emergency.

In terms of what type of alcohol—ethanol, methanol, or formulated alcohol fuels—I believe we should let advancing technology, local conditions and free market practices make that determination. I suspect we need all forms of fuel grade alcohol to meet our needs, particularly during a national emergency. The challenge is to get on with the expansion of the alcohol fuels industry so that we can ensure an adequate supply of food at all times and thereby strengthen our national security.

The technologies already being developed within this new industry will soon be advanced to the point where they will be ready for export to other countries, particularly the developing nations. This will in turn permit them to enhance their national security using locally available resources.

Thank you, Mr. Chairman, for the opportunity to present my thoughts on this important subject.

STATEMENT OF LARRY WERRIES, DIRECTOR, ILLINOIS DEPARTMENT OF AGRICULTURE

The Illinois Department of Agriculture and the State of Illinois support the proposed legislation referred to as "Surplus Agricultural Commodities Disposal Act of 1982" (H.R. 6142).

Granted Illinois probably has more to gain than some states because it is a large corn producer and presently produces 70 percent of the country's fuel ethanol. However, the entire country will share many ways from the benefits of the legislation—a few are listed below.

1. CCC storage and transportation, handling and interest costs could be reduced drastically.

1a. USDA estimates it costs $1.70 per bushel every two years to cover the charges on forfeited price support commodities.

2. Reducing the burden of over supply therefore would tend to improve and stabilize commodity prices.

2a. Dr. Tom A. Hieronymus, noted University of Illinois economist, estimates that for each 1-percent disappearance of corn the price will improve by 2 percent.

3. Any quantity of fuel ethanol produced beyond the immediate federal fleet needs could be utilized in the strategic reserve for national defense.

3a. Properly stored alcohol fuel has almost endless life.

4. Certainly we would reduce our dependence on foreign petroleum fuel.

5. Anytime we can process commodities in the United States employment is increased.

6. Anytime straight or blended alcohol fuels are burned air quality is improved especially in densely populated areas.

7. With less commodities in storage—thus enabling rotation—higher quality of food and feed products would be the result.

[From the State Journal-Register, Springfield, Ill., March 26, 1982]

FILL THE SPARE TANK

The strategic Petroleum Reserve (SPR) is a giant gas tank. Right now, it's got about 240 million barrels of petroleum in it. America's goal: one billion barrels of crude oil.

We started filling the SPR after the Arab oil boycott, in order to prevent a repetition of the gas lines should there be another energy crisis. In 1980, we filled 100,000 barrels a day. In 1981, President Reagan more than doubled the amount in storage, filling as many as 300,000 barrels a day. Meanwhile, petroleum was completely decontrolled, conservation slowed consumption, and lo and behold—a world oil glut.

Now prices are going down. Ironically, so is the amount being pumped into the SPR tank. Why?

Because the salt domes where the oil is being stored are nearly filled up. Construction of new geological caverns and steel tanks is expensive. To cut $400 million in construction costs, the administration wants to slow construction of the new SPR cavern in Texas called Big Hill. The delay will mean that we'll only store 209,000 barrels a day in the SPR—delaying its reaching the 750-million-barrel level from 1989 to 1990.

This sounds like the man who refused a bargain price for food staples because his cupboard was too small. That year, farmers produced bumper crops. Every day the farmer went to the store and bought the day's flour at cheaper and cheaper prices. He laughed at his neighbors who'd invested money on building big storage closets which were filled with expensive flour. Then the next year there was a drought. Staples disappeared from the store shelves. Our friend had money, but nothing to buy. His neighbors ate bread.

No one knows how long the oil glut will last, or how low the price of oil will fall. John H. Lichtblau, a petroleum researcher, says: "Given the importance of a large SPR . . . we cannot forego the purchase opportuity which the world market currently affords—short-term budget restraints notwithstanding." He suggests that America could find temporary storage for 100 million barrels of oil. Storage on oil tankers could be as inexpensive as $3 a year per barrel. That's a big extension to the cupboard for a relatively low price.

The oil glut could disappear with the speed of an air strike in the Mideast. America has an insatiable thirst for about 550,000 barrels of petroleum a day.

Fill up the spare tank.

TERROR THE STRATEGIC TOOL: RESPONSE AND CONTROL

by

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ABSTRACT

The U.S. appears ill-prepared to deal with an emerging form of interstate rivalry; that is, the use of terror as an unconventional weapon to achieve conventional political ends. The terror event represents a powerful form of leverage simply because of its media value. Using media coverage to amplify its impact, acts of terrorist violence have paralyzed western governments and undermined their credibility. In a destabilized international environment, the vectored terrorist threat offers additional advantages to radical nations or superpowers in pursuit of foreign policy objectives. Under the guise of criminality, it can become a low cost, low risk, high leverage tool of low intensity warfare, difficult to combat because uncertainty about the origin of the threat limits the full range of diplomatic and military responses.

THE DIMENSIONS OF THE PROBLEM

International terrorism is a new class of violence, beyond the norms of common criminality, which exploits today's advanced technologies, especially jet transport and instant global communications.[1] Regrettably, it is becoming established as a world-wide, steady state phenomenon.[2]

Hardly a day passes without a terrorist incident occuring somewhere in the world; it pervades the fabric of contemporary civilization. Although the United States has not so far been a primary target of attack, any optimism that this benign state of affairs will continue is misplaced. Terrorism has, among other things, become part of the arsenal of international warfare, recognized as a useful tool of low-intensity conflict. As a surrogate means of warfare, terrorism also becomes a tool of strategic importance. We must recognize the promotion of such violence from the level of a criminal act or political nuisance to a matter deserving serious national attention.

The significance of the terror act has been raised exponentially by several different but interrelated factors. First, the tools available for destruction are suddenly much more lethal and much more frightening than ever before. Second, the media attention focused on terrorism is immediate, global and usually undisciplined. Third, motives for terrorist attack today span a spectrum that includes, at the extremes, personal grudges and superpower ambitions of global hegemony -- and there is little certainty as to which underlying motive may really be at play in any particular case. Finally, this nation (unlike others in the Western Alliance) has no internal consensus on how to respond to either acts of supercriminal violence or coercive political threats; has no common philosophical basis for accepting the high costs (in lives, materials, pride and power) of occasional failure in dealing with terrorism; and has no internationally recognized commitment to firm, retributive deterrence of such violence.

Although terrorism is a ubiquitous phenomenon, it is nearly impossible to define formally. The range of violence we have labelled "terrorism" extends from the hijackings of aircraft at pistol point to car bombings, from the senseless destruction of lives and property at the Bologna train station to the attempted assassination of the Pope in Rome. In the absence of either a generally accepted definition or of a new taxonomy, the term "terrorism" can be used as a shorthand to describe the kind of violence (either threatened or real) exercised for political ends but outside of all normal political relationships.

Terrorism is manipulative; it seeks to turn an opponent's strengths against him. For example, it can exploit the technological, cultural, and legal infrastructure of a state against the state's own interests. This type of exploitation is particularly successful in cultures with strong traditions of personal freedom and limitations upon executive power; these cultures already endure a degree of disorder as the price of democracy and are less able than others to respond uncompromisingly to terrorist threats. By contrast, terrorism is relatively ineffective in totalitarian societies where it is simply denied an environment for existence as a matter of state prerogative. To be effective in a totalitarian culture, terrorism must be raised to the level of full scale revolution.

Unlike the totalitarian states, the West has had relatively few unequivocal successes in the face of terrorist activity. Embassies have been seized with inpunity. Governments have been perceived to capitulate in the face of terrorist threats. Since 1972, terrorists have elevated the arts of assassination, hijacking, kidnapping, arson and bombing into the public domain, paralyzing Western nations and damaging the credibility of their governments. At Munich, terrorists took advantage of German unreadiness and mounted a vicious assault on the Olympic Village. For a relatively small investment -- the lives of the terrorists involved -- they relied on television to shock a hundred million onlookers around the world. At the 1975 OPEC minister's meeting in Vienna, a terrorist act humiliated the Austrian government, clothed the criminal terrorist Carlos in a Robin Hood image of international appeal, and advanced Libya and the PLO to the forefront of the radical Arab world. The 1979 seizure of the American embassy in Teheran by a mob of uncertain allegiance paralyzed our nation for a year and probably altered the course of American electoral history. America's paralysis was converted into ignominy when the rescue attempt failed before even actually under way. No atomic bomb could help. America failed diplomatically and militarily to deal in proportionate terms with the immoderate behavior of a rogue nation and with the terrorist tactics of sub-national elements. The very high cost to America's leadership of the West has yet to be assessed.

The role of the media in such incidents is pivotal. It provides enormous political leverage to an act which, on its own, would simply be an example of criminal barbarism. The terrorist uses the media in a way democratic governments cannot. As a result, governments have often appeared inept -- unable to defend themselves against a relatively small criminal element. Eventually, however, governments do learn to counteract the first generation tools of terrorism and both the media and public become inured to a given level of threatened or actual violence. At that point terror, like a disease organism in the face of antibiotics, must mutate to survive both physically and in the public eye.

Libyan death threats against the President and attacks against high ranking NATO officials presage a new form of adaptation. These incidents highlight the fact that -- by careful target selection and by using the media to amplify the effect -- terrorism can become a strategic instrument of policy influence as well as a tactical tool of social disruption. Whether or not the Libyan hit team actually existed became irrelevant. The threat itself forced the President to retreat into a "steel cocoon" and appeared to paralyze the American government. Responding to this governmental posture, the media were led to overplay the matter and the incident emerged as a self-inflicted act of terror with Colonel Kadaffi as the catalyst.

It also made clear that America is not immune from the terror event -- either at home or abroad. If the usually random act of violence can paralyze a government, as we have seen, the strategically directed terrorist attack is potentially devastating. The United States appears unready to cope effectively with either tactically or strategically inspired terrorism -- and that very unreadiness invites attack. In the immediate future, America can expect to join its European allies as a victim of terrorism, playing the unwilling co-star in a media event which undermines the government's credibility internationally and weakens it in the eyes of the domestic electorate. Unless the United learns to deal at home and abroad with the phenomenology of terrorism in the longer term, it should expect to see its substantive strength sharply reduced as terrorism replaces conventional hostilities in the international allocation of power.

ADAPTATION AND THE MEDIA MULTIPLIER

It may seem inconceivable that tactics of terror could be used successfully against a nation as powerful as the United States or indeed any industrial nation. No band of terrorists is a match for the smallest standing army or indeed any metropolitan police force. None can command the resources of the tiniest nation. Yet, terrorism has been characterized as a world-wide menace. The terror event enjoys an unparaelled power simply because of its media value.

Of all the reasons for terrorist success, the platform offered by the enthusiastic media is by far the most important. Terrorists have used the media as a springboard onto the world stage. As a result, the terrorist assault has come to resemble highly choreographed theater, the Western media inadvertantly emerging as an adversary of liberal democracies by working in de facto partnership with terrorists.

Both government and terrorists alike operate in the glare of the media spotlight. Without that attention, the outcome of the incident becomes relatively insignificant. The militants in Iran recognized this as an essential ingredient of success and acted accordingly. By encouraging regular media coverage, the terrorists made the torment of the hostages an integral part of everyone's life. The fifty-four quickly became so well known that any action by the United States which could have jeopardized their lives would have engendered severe political penalties.

The media molds public perceptions about the success or failure of the terrorist operation, about official competence in the face of the threat, and about the prowess of the terrorist organization. For example, Israel's desperate decision to resist escalating terrorist demands and its attempt at a high risk rescue at Entebbe were depicted by the media as a major triumph. The Germans at Mogadishu basked in the same affirmative limelight. By contrast, the American experience in the Iranian desert was presented not simply as a justified attempt that failed, but as a debacle, a symbol of American command weakness and Presidential bungling.

As a terror event unfolds, the media's involvement creates a peculiar synergy between the government, the public, and terrorists. Each of the actors participates directly in the event -- creating, in effect, a spectacle with a participative audience. The problem comes when the level of violence loses its media sex appeal, when the next airline hijacking or kneecapping is no longer spellbinding news.

To maintain the media spotlight, the terrorist organization must heighten the threshold for the spectacular assault. Accepting the thesis that a primary goal is governmental disruption and that there must be an aura of "Broadway" presence about the event, we can speculate about the next phase: terrorists will be forced to adapt their methods, their tools, and their targets to stay ahead of government preparations and assure front-page coverage.

As governments have learned to counter commonplace terrorist attacks with specialized rescue teams -- the Delta Force in the United States, the GSG-9 in Germany and the Saiyeret in Israel -- the dangers of forced adaptation or mutation automatically increase. While amateurs may continue to rely on the time tested tactics like sky-jacking or embassy seizures, the imaginative professional terrorist will alter his methods to ensure surprise, panic, and genuine disruption.

Terrorist organizations are being forced to adapt not only because their more traditional tools like sky-jacking no longer attract the desired media attention, but because these older methods can be defeated. While governments learn slowly, they do learn. The terrorists must keep one step ahead of government's ability to respond in order to survive both physically and in the popular eye.

A number of avenues are open to them: attack the infrastructure of metropolitan areas (systems such as the electric or natural gas networks, communications or computer facilities appear particularly vulnerable); threaten thousands of people with agents of mass destruction (nuclear explosives, chemical or biological weapons can all serve this end); or find subtle political levers to exploit (the anti-nuclear and environmental movements in the U.S. and in Europe are potential targets for infiltration.)

Attacks on the society's infrastructure have already occurred. The New World Liberation Front has targeted Pacific Gas and Electric some 70 times albeit with minimal damage. The Red Brigades attempted to knock out the electric power system in Rome, following the Aldo Moro kidnapping, but created only a minor power failure. Nuclear power stations in Spain, France and Germany have been unsuccessfully attacked. A raid on an FALN safe-house prior to the 1980 Democratic National Convention turned up detailed plans of the power system of Madison Square Garden, perhaps signalling a plot to black out the facility and disrupt the electoral process. To date, these terrorists attacks have been largely ineffective, but they raise the prospect of very large disruptive impacts being created with very few human and material resources.

As Western civilization has grown dependent on technology for survival - and the technological infrastructure vertically stacked with little room for redundancy - society's vulnerability to attack has become increasingly obvious. Certainly, electric generation and distribution systems, computer networks, nuclear installations, port facilities, water systems, and oil refineries proivde leverageable targets. Too, certain responsible organizations have enough evidence to lead some to conclude that terrorist groups have been recruiting technical talent to correct past failures.

Terrorists have employed whatever portable and concealable anti-tank and anti-aircraft weapons they have been able to obtain. In 1973, PLO terrorists were apprehended attempting to knock down an El Al jet at the Rome airport. In 1976, members of the PFLP were arrested at the perimeter of the Nairobi airport preparing to fire at an El Al jet coming to land. Less than a year ago, an anti-tank missile was used by the Red Army Faction in the attack against General Kroesen's car in Germany. We must face the prospect that the spectrum of potential disruption is becoming substantially enlarged and may even include the threat of nulear or chemical weapons. Although the means of mass destruction have become increasingly available, their use by terrorists would represent a quantum jump and likely backfire by assuring an overwhelming governmental response and the terrorists demise.

On the other hand, the degree of threat need not be raised to achieve a greater scope of disruption and requisite media attention. What is equally plausible -- albeit more subtle -- is a political adaptation of the threat. Instead of isolated attacks against individual nations, terrorism can heighten its leverage by careful selection of targets within the international community. The level of violence can remain the same but the effect can be expanded dramatically.

The attacks on General Kroesen in Germany and General Dozier in Italy represent a new form of "cushion shot" terrorism. Dozier was not merely a high-ranking official whose kidnapping might seriously embarrass the American government, he was a symbol of the Western Alliance. His kidnapping was designed to provide the Red Brigades with power to influence, through the media, the outcome of issues of great political import: the structure of the Western Alliance and the decisions on theater force modernization.

It is essential to distinguish between a routine terrorist kidnapping for extortionate purposes and the Dozier case. The former is straightforward: there is a hostage to be traded for meeting a specific set of demands. In the latter, the elements are considerably more complex. Using the same tools, the Red Brigades were in position to attack a range of targets -- the military, the U.S. government, the Italian government, even the NATO alliance. Using the media as a springboard, the terrorists attempted a "cushion shot" to capitalize on the political strains in the Alliance and the growing world-wide anti-nuclear movement. Had the terrorists chosen another day -- not the one in which events in Poland and the Golan Heights overshadowed their drama -- the U.S. government as well as the entire alliance would have been even more seriously embarrassed.

The Dozier case highlights the possibility of ever stronger leverage and broadened scope of attacks. It has made clear that NATO is a vulnerable terrorist target. Colonel Kadaffi's threat alone, following the Gulf of Sidra incident, to attack a nuclear weapons storage facility in Europe is another example of "cushion shot" terrorism in that it involves many international interests at little current cost to Libya.

The vulnerability of our technological and political infrastructures creates new targets of strategic value -- attractive not only to sub-national terrorist organizations but to nation-states as well. The possibility that nations will adopt such tactics -- sometimes under the guise of common criminality -- is a very real threat. The instant and global media attention that such threats would command poses a major dilemma for balanced political response.

If the U.S. and other large nations are not to be embarassed or unduly damaged by the terror event and the press left unrestrained, improved cooperation between the two will be essential. Although the media have developed internal codes of ethics, the fierce competition among the television networks and wire services has not always been conducive to self-restraint. The reporting of the Iranian hostage seizure is an excellent example of how the media can overdramatize an incident, creating a public perception of governmental impotence. The media must recognize its power to affect the outcome of an event and act responsibly. By the same token the government has certain responsibilities to the media. For its part, the government should develop more creative means of consultation and a system of accurate information dissemination during the incident so that a better working partnership can evolve. If we fail to forge these improved working accommodations, we run the serious risk of seeing some form of institutionalized censorhip resulting from a mishandled terrorist incident.

THE GEOPOLITICAL CONTEXT

The next several decades appear ripe for unconventional forms of conflict among nations as the age of great power dominance is replaced by a more fluid pattern of international relations. As power and influence become increasingly diffuse, the traditional mechanisms of restraint will become decreasingly effective. The international system will be marked by growing uncertainty simply because of the proliferation of key actors and advanced weapons on the world stage. It will be far less clear who can do what to whom, why, and with what effect.

We should expect that the very diversity of actors -- each pursuing their own interests -- will expand the opportunity for international conflict. It is important to understand how the international environment itself might encourage low intensity conflict as a means of achieving foreign policy goals. For the purposes of this analysis, the evolving international context can be characterized by the following general propositions:

- The social, political, military, and economic conditions which sustained the NATO Alliance have so diverged as to place at risk the concept of the alliance itself. For twenty or thirty years, the superpowers played at a "zero-sum" game in which winners or losers were clearly identifiable. That era of bipolar confrontation has been transformed into an ambiguous multi-actor age in which the spheres of influence of the superpowers have shrunk considerably. Neither can dictate, with any certainty, the desired or apparent course of political or military events. Increasing superpower dependence on Third World countries for economic prosperity, military leverage, and international support have rendered the superpowers more vulnerable to the changing and frequently turbulent environment. In particular, the emergence of a federated Europe, a politically active Japan, and an internationalist China will radically affect the division of power between and among the major elements of the East and West.
- The ambivalence in Europe about the Alliance will continue to be a forcing function in US-NATO relationships. NATO is not robust and shows signs of political and military stress. There is dissension among the partners over a number of issues -- not the least of which is what constitutes adequate military deterrence of perceived Soviet Union political ambitions. Western Europe,

as an entity, will become more assertive in adopting alternative policies on issues like security, energy, Middle Eastern peace arrangements, and East-West relations. This trend is likely to be mirrored in the Eastern bloc -- albeit perhaps not at the same pace. Europe as a whole may inch toward "Swedenization", with concommitant challenges to superpower leadership on both sides.

o Western European military considerations have changed the nature of the central battleground. Twenty years ago, we compensated for our inability to match the Soviets man-for-man and tank-for-tank with a dominant nuclear force, hoping to deter by deploying the products of a decisive technology against sheer numbers and brawn. Today, we are not only outnumbered in men and tanks, but have no monopoly on superior technology, including smart munitions. The Alliance cannot match the Soviet Union in general purpose forces. Moreover, our tactical nuclear force in Europe, designed to bolster an uncertain conventional defense, offers too great an opportunity for unwanted escalation toward nuclear holocaust. From the Soviet vantage point, internal ethnic and economic dilemmas as well as problems on their periphery -- in Eastern Europe, Afghanistan, and China -- affect their willingness and capability to keep up an impregnable front against the West. They can afford an arms race about as much as we can. Neither the U.S. nor the Soviet Union wants to risk large scale confrontation.

- Competition among industralized nations for scarce resources will intensify. The Achilles heel of technological civilization has been globally bared over the past decade: dependence on raw materials for economic growth and in turn , for national political stability. Competition for resources may override, in some cases, efforts at international cooperation. Possession of resources is already being used as a tool of political leverage. As specific raw materials become economically scarce, either physically or by design, we should expect that international frictions over their distribution will intensify.
- Political and economic power will become increasingly liquid. Since the establishment of OPEC in 1973, the world has witnessed a transfer of capital and skilled manpower resources unprecedented in civilized history. The oil crisis introduced a new format for relations between the industrialized and industrializing world, setting a non-linear pattern into motion. The reality of interdependence provides the undeveloped nations not only economic but substantial political leverage over the industrialized world. The international politics of Third World countries will be characterized in the coming decades by evidence of real political

independence and shifting alignments in relations with the superpowers. At the same time, the process of economic differentiation among Third World countries will create internal and bloc instabilities. The accompanying political unrest will enhance opportunities for subversion and use of proxy military forces in high gain/low risk situations by virtually any class of power, not just the advanced and powerful.

- The traditional diplomatic and military policies of the United States will be inadequate to meet the real challenges of the future. As a result of economic and political constraints, the U.S. will not be able to afford to tailor its forces to meet even every likely contingency. Our ability to project power in the Third World can be expected to become increasingly precarious -- particularly in an environment both hostile and better prepared to resist intervention. Increasingly, we are recognizing that there are limits to force -- even overwhelming force.

In such an ambigous and complex environment, unconventional forms of warfare become more attractive. For the relatively weak, the high leverage/low cost factor is essential since they cannot afford to compete militarily or economically. For the more powerful, the high leverage/ low risk element is decisive since the costs of large scale conventional or even nuclear confrontations are unacceptable.

Techniques of unconventional warfare are not a new dimension in the kinetics of international rivalry. For example, disinformation, espionage, overt or covert thefts of high technology, export of undesirables as refugees (as in the Cuban case) and support for movements of national liberation have long formed part of a spectrum of low intensity conflict. What is new is an international climate which appears to offer a strategic rationale for unconventional warfare. What is also new is that terrorism may become a major and perhaps dominant part of that spectrum.

Used as a strategic weapon, the vectored terrorist threat offers certain unique advantages in the pursuit of foreign policy objectives. Although unimpressive in firepower, it is profound in leverage. Too, the initial uncertainty about the origin of attack often limits the full range of diplomatic and military response. For the Soviet Union and its proxies -- certain of the radical national and sub-national groups already on the terrorist scene -- terrorism may offer an irresistibly low-cost, low-risk means of engaging the West in low intensity conflict.

The new class of "violence manipulators" we can expect to see grow in importance over the next few years includes: sub-national terrorist groups, harbored willingly or unwillingly by various states, which seek to disrupt Western societies; Third World countries willing to exploit the tools of terrorism directly for their own ends; and larger powers which desire to manipulate international events without running the risks of formal military confrontation.

None of these actors operates wholly independently. The Soviet Union has provided funding and support for terrorist operations via Eastern Europe and its client nations like Libya or Cuba. With tacit Soviet approval many groups have trained together in Cuba, Libya, Iraq, South Yemen and Lebanon. Informal alliances among the members of different groups have often occurred. Palestinian and German terrorists operated together in the 1975 OPEC hostage incident and the Entebbe sky-jacking. It has been speculated that Red Brigades cooperated with Germany's Red Army Faction in the Dozier case. The PLO has provided aid and assistance to the Japanese Red Army (and were perhaps repaid in the Lod Massacre); the PLO, in turn, has received assistance from a number of Arab nations, such as Libya, which has supported groups as disparate as the Irish Provos and the right wing Italian groups. This overlap in objective and method raises the specter of an international network for terrorism -- a master conspiracy of disruption. Indeed, the Reagan Administration declared early on that the Soviet Union was responsible for virtually all international terrorism, using it as a tool of surrogate warfare.

While there is incontrovertible evidence of Soviet involvement, the Administration has not produced an actual "smoking gun". Terrorism, on the whole, is too complex an issue to be easily explained away as an example of Soviet interventionism. Even if the Soviet Union withdrew all patronage, terrorist activity would certainly continue, perhaps unabated. Terror has other independent patrons, currently the most prominent being Libya. Libya, for example, has become quite involved in Central American and Venezuela -- having gained some influence with the media and with a number of ranking officials.[3] This kind of link is of primary benefit to Libya in its quest for a leadership role in OPEC. Venezuela provides a natural platform for Libyian terrorism disguised as economic or political nationalism. While there might be tacit support from Moscow, there is little or no evidence that Libyan activities are planned or directed by the Soviets. The terror mechanism represents too useful a tool of low intensity conflict to be discarded by any small state operating on its own behalf.

Moreover, sub-national terrorist groups have matured into self-sustaining organisms; there is no organic need for a master conspiracy. Terrorist organizations are not mirror images of each other, even when there is a broad intersection of interest. Each group learns from the experiences of others,its tactics evolving in response to governmental countermeasures and in the spotlight of media publicity. Hence, a loose confederacy of terrorist groups operates quite successfully without the limits that centralization would impose.

Contemporary terrorism offers few grand visions of a better world.[4] Increasingly, it has become a strategic tactic, whether employed by neo-nihilistic sub-national groups or by nation-states. As a result, the days in which terrorism was confined to isolated instances of social disruption are over. The destabilized international system provides the opportunity for profound disruption while the vulnerability of the West, in terms of its unprotected technical and democratic political infrastructure, offers the avenue of attack.

THE ISSUE OF RESPONSIBLE RESPONSE

The conclusion that the U.S. has no immunity to terrorist attack appears inescapable. We should expect an increase in both the absolute number of violent events and in their qualitative importance; we have already experienced exported terror striking at the exposed nerve centers of the American system with attempts on the lives of Presidents, candidates, and key leaders. We are increasingly aware of the rising internal social stresses that provide potentially exploitable "cushion shot" situations -- the U.S. has its own growing anti-nuclear movement;

environmentalists are being affronted without the courtesy of facesaving compromise; the Black, Hispanic, Asian, refugee, and American Indian ethnic minorities perceive their share in the American power system as shrinking rapidly; a class of newly economically disenfranchised former producers and wage earners is beginning to coalesce around an emotional opposition to Administration policies; middle-class resentment against being forced to abandon the political center under the constant harassment of single-interest ideological radicals is pointing toward eventual severe pendulum reactions -- in short, there is no shortage of social and political ferment that has found little satisfaction in the traditional and legitimate means of relieving societal stress. There is a natural quixotic character to America (exploited by the press) that rejoices in hero worship of criminals and rebels -- another potential access route into our society by those not dedicated to its survival. The global political process is in growing disarray, with the traditional networks of intra and international relations collapsing without alternatives in place. The temptation to rely upon unconventional action mechanisms to achieve conventional political ends is becoming irresistible.

At the same time that the U.S. is exhibiting (and, hopefully, recognizing) its growing societal vulnerability to terrorist activity; the range of terrorism to which the society is subject is broadening dramatically. Sophisticated weaponry is widely available now, and it is not much longer before, in the opinion of observers, chemical and biological weapons of mass destruction will be available to the international terrorist community. Although quite improbable, a few argue that terrorists will get their hands on nuclear explosives. Perhaps more important, the terrorist community itself may become more technologically sophisticated (increasing the scope and vulnerability of possible targets) and psychologically disciplined (maximizing the impact of each threat or event). With U.S. interests (and the media able to report them) being world-wide in scope, terrorist acts directed against those interests are not preconstrainted or channelled by factors of geography time, class of target. The phenomenon has become transnational. And whether the terrorist act is eventually traceable to some small group's nihilistic fanaticism or to some major nation-state's political needs, the surface truth remains the same: in face of an escalating threat of serious physical and political proportions, the U.S. is not prepared to respond except reactively.

Whether international terrorism is a form of warfare or not, responsible response begins with a public policy structure that recognizes the issue, places it in proper perspective among the hierarchy of standing problems on the national agenda, and provides useful operational guidance to those who will be dealing with specific future incidents. It should promise with chilling certainty to all who trespass against U.S. interests in this manner that eventual retribution will be exacted from actor and instigator alike. It should engage the confidence and common sense of the American people and not be regarded as just another governmental activity divorced from the real business of the country.

Having matters in hand, or at least appearing to have them so, implies advance preparation. Certainly, "luck" enters into the equation, but so do well-conceived organizational arrangements, ironed-out juridictional questions between local, state and federal authorities and planned uses of technology. Such contingency planning is basic if America is to meet the terrorist challenge. Its objective is not to prepare for specific crises, but to develop modes of operation and an awareness of available resources, to gain quick access to those resources and understand the logistics involved in using them. Gaming exercises, aimed at developing smooth working routines in crisis conditions, are a requisite of contingency planning. The creation of a professional U.S. "Red Team" of imaginative simulated terrorists would provide realistic training and testing opportunities at many levels of threat. Another area of exploration is to use technology to harden the target, to reduce the terrorists capability for damage and to deny him the leverage he seeks.[5]

Exactly because the society itself is hostage in the largest scale terrorists extortions (e.g., those involving nuclear or biological materials, those attacking the life-support infrastructure of food, energy, and water), the society must embrace philosophically the quality of mature response that the threat warrants. A danger in the past has been a tendency to downplay the overall threat and to treat each conventional incident on its own theatrical merits; a graver danger of the future is the probability that unconventional incidents will have much greater impact than they perhaps warrant and will be allowed to resonate until they eventually fractionate some of our important stabilizing social and political structures. As noted earlier, the singular position of the media in this field imposes some responsibilities for identification with the national interest not exercised since the Second World War.

And finally, there is one other major player whose early involvement during policy formulation and continuing involvement during the periods of active response to incidents is often overlooked: the judiciary. While not likely to reverse the long tradition of adversary relation between Executive and Judiciary in the general confrontation between social order and individual liberty, the continuing involvement of judicial attention to matters which carry the seeds of social annihilation should allow the full majesty of the law to operate effectively and swiftly in response to extralegal violence and blackmail.

Ideally, the society attacked by terrorists reacts at three hierarchical levels. First, there is the immediate isolation and reduction of the specific incident, much in the manner of the treatment of dangerous disease. Second, there is the phase of domestic and international "damage control", or dealing with the derivative and delayed political, social, economic, security, and military implications of the event being treated; this can range from reassuring international partners that basic commitments will be upheld (after, say, a nuclear incident) to emergency economic recovery programs (after, say, the breakdown of a city's water system). Third, and probably least considered, is the phase of creating opportunity from adversity and consciously using the incident (in its fullest sense, including success or failure in containment and in dealing with its larger fallout implications) as an element to move forward basic national policy. The alternative, to try to encyst such events and then rely on the passage of time to remove them from the public consciousness, has two grave disadvantages: it continues to attract new incidents because the field is always fresh for public exploitation; and it suppresses inquiry into the root causes of this class of violence, which, if addressed as part of the political process, would be greatly weakened by routine and open review. By incorporating the ill-fortune of terrorism into the rationale for forward flow of programs, policies, legislation, and individual activities, it would seem that the nation's vulnerability would decrease markedly. Once a risk is recognized as quotidian and incorporated as such in the public consciousness, the kinetic energy of that risk in social terms is expended with little real effect. In short, a mature technological society can absorb the instabilities caused by occasional lack of success in managing the symptoms of terrorism; it is a matter of social perspective, of informed personal choice, and of educated expectancies backed up by a first-line defense of sound independent policy, quality intelligence, rapid controlled resource allocation, and a straightforward mechanism for making difficult decisions quickly.

Does the U.S. today have either the maturity to accept and constructively respond to the terror problem or the political structure to deal with its gross overt manifestations? It is not untimely, during this current period of reassessment of federal, state, and private responsibilities for the health of the Republic, to examine carefully the machinery of law enforcement, national security, and civil emergency reaction -- machinery intended to deal with the whole array of foreseen and surprising domestic and international crises we will undoubtedly face over the next decade ranging from earthquake and famine to nation-scale terror and violence. It is within that machinery, which needs for its own reasons to be streamlined and made potent, that we should inconspicuously absorb the new elements of global terrorism intelligence assessment, protection of key national infrastructures (by hardening, by redundancy, and by inaccessibility), and realistic contingency planning and practice that involves the hierarchies of authority as well as the public and the media. If the U.S. cannot, out of indecision, or will not, out of ignorance, act now to better meet its future challenges, the costs in the decades to come will be paid in the currency of national humilation and social disintegration.

FOOTNOTES

1. Brian Jenkins is undoubtedly the first scholar to make this point. Among his well known writings is:

Brian Jenkins, Terrorism: Trends and Potentialities (Santa Monica, California: The Rand Corporation, 1977).

2. In addition to Brian Jenkins' numerous writings, there are other excellent surveys of the terrorism phenomenon. These include:

Yohah Alexander, ed. International Terrorism: National, Regional and Global Perspectives (New York: Frederick Praegar, 1976).

J. Bowyer Bell, A Time of Terror: How Democratic Societies Respond to Revolutionary Violence (New York: Basic Books, 1978).

Walter Laqueur, Terrorism (Boston: Little, Brown and Co., 1977).

3. In November of 1981, a conference was held in Caracas which included individuals suspected of terrorist connections, causing heated debate and embarassment in the Venezuelan government.

4. Walter Laqueur, "Terrorism -- a Balance Sheet" in The Terrorism Reader ed. Walter Laqueur, Meridian Press (NY, 1978) pps 251-267

5. For more detailed information see: Robert H. Kupperman and Darrell Trent, Terrorism: Threat, Realtiy, Response, Hoover Institution Press (Stanford: 1979).